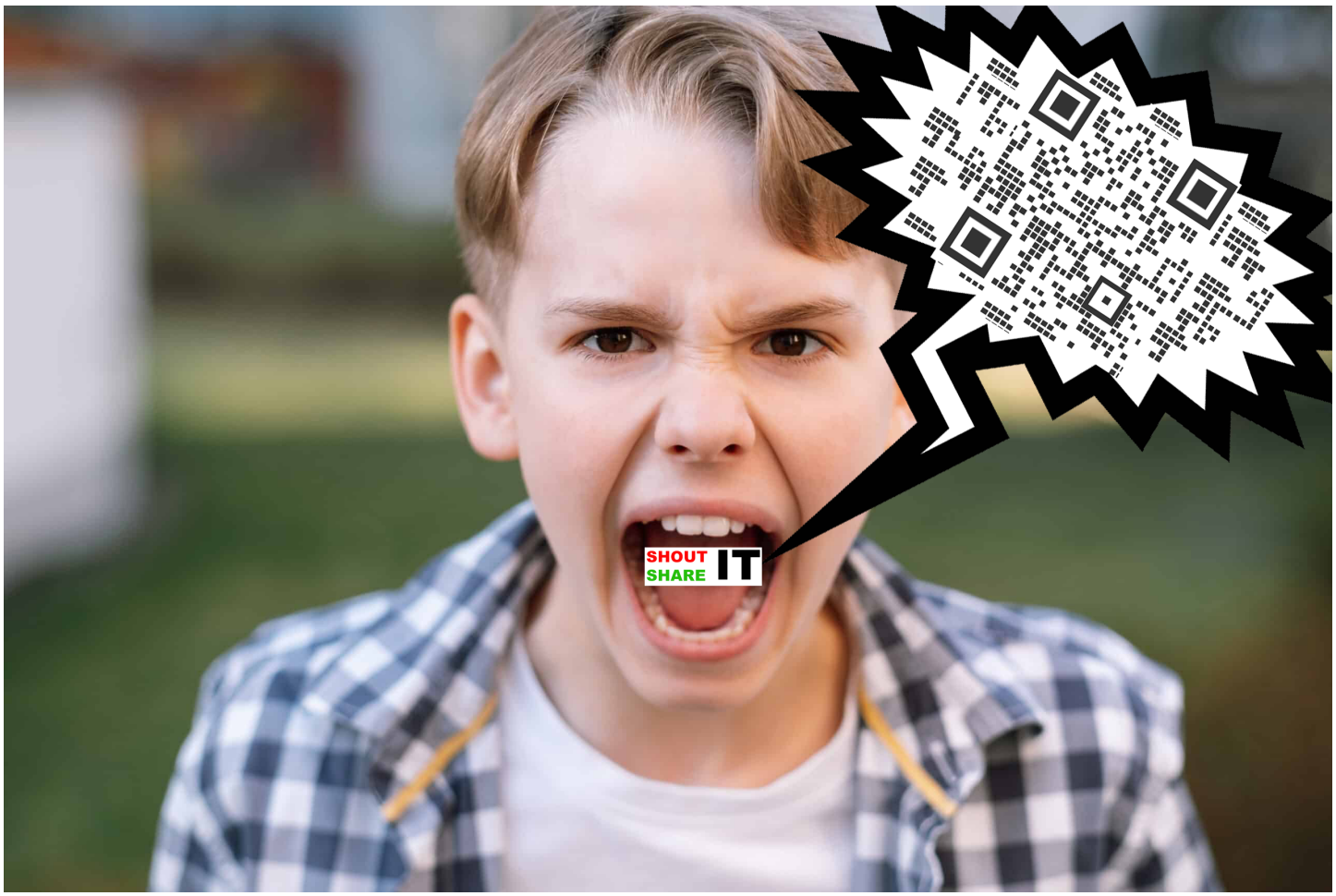
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The Great Basin Naturalist

VOLUME 30, 1971

Editor: Stephen L. Wood

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Brigham Young University

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The *Great Basin Naturalist* was founded in 1939 by Vasco M. Tanner. It has been continuously published from one to four times a year since then by Brigham Young University, Provo, Utah. In general, only original, previously unpublished manuscripts pertaining to the biological natural history of the Great Basin and western North America will be accepted. Manuscripts are subject to the approval of the editor.

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Volume 31 March 31, 1971 No. 1

A COMPREHENSIVE INDEX TO THE *GREAT BASIN NATURALIST*, VOLUMES 1-30 INCLUSIVE 1939-1970

Vasco M. Tanner[1]

The *Great Basin Naturalist* was founded in July 1939 by Vasco M. Tanner, who has remained as its editor until December 1970. During this period, thirty volumes have been published. The aims and purposes of the publication were set forth in the first issue, July 25, 1939, as follows:

> This publication, to be known as The Great Basin Naturalist, will contain in the main the results of investigations dealing with the fauna of the Intermountain States. It has been apparent for some time that such a publication would be of service, as an outlet for the results of research, to the workers at the Brigham Young University, as well as other investigators of this region. It will also help to make more available to students the printed results of studies relating to the natural history of the Rocky Mountain States. For years papers have been published in various periodicals in this country many of which are not accessible to the students of the universities, junior colleges, and to the same extent the museums. The fauna of this region is far from being well known. The natural habitats are fast becoming changed due to grazing of livestock, agricultural activities, forest fires, and floods. Civilization is bound to bring about radical ecological changes, and the extinction of many of the endemic species. Reports upon collections that have been made, and the results of field studies, should be recorded. It will be our policy, therefore, to publish finished research papers, progress reports, and notes dealing with the physiology, morphology, ecology, and taxonomy of the animal and plant life of this region.

There have been many changes take place in the terrain, as well as the fauna and flora of the Great Basin since the explorers, trap-

[1]Department of Zoology, Brigham Young University, Provo, Utah.

pers, and Mormon Pioneers invaded its vastness 195 years ago. The balance of nature as it was when Escalante's party traversed the central and southern parts of Utah have been greatly modified and will continue to be so in the future. It has taken the public, in this mountainous region, 100 years to learn that they have operated under some mistaken policies in dealing with the soils, water, plants and animal life. Erosion of the watersheds due to excessive grazing, lumbering, and fires, development of new lakes and draining and modifying of old established ones, has brought about irreplaceable changes and in many cases the elimination of endemic species of plants and animals.

In the pages of this journal may be found many reports relating to the changing biota of the Great Basin, as also the descriptions of new taxa.

It has been a pleasure for me to have fostered the *Great Basin Naturalist* from its inception to the present time. There were times during World War II when funds were pinched and few manuscripts were available. The annual volume in some years was limited to one issue, consisting of a combination of the four quarterly numbers. It was under these conditions that I was almost convinced that the late editor and entomologist, Clarence H. Kennedy, was correct in surmising that I was dreaming and was on an erratic course in attempting to found a new journal. Said Kennedy, "We cannot believe that such a perfect journal can last long, at least in its present form. Perhaps it can metamorphose and come up tough and enduring, a true product of the desert whose fauna it discusses."[2] The journal has withstood the challenge, has toughened up and endured to this time.

It was largely through the encouragement and support of Brigham Young University President, Franklin Stewart Harris, a great scientist, that the journal survived. Dr. Harris constantly urged faculty members to engage in creative thinking and research and to finish their endeavors by publishing the results of their studies. During the past decade, President Ernest L. Wilkinson, and Ernest L. Olson, director of University Press, have provided financial aid and assistance to the program of the *Naturalist.* The *Great Basin Naturalist* was one of the first publications at BYU to be used for exchange purposes by the University libraries.

In preparing this comprehensive index, I have felt that the usefulness of contributions contained in the volumes will be more readily accessible to students and researchers who may use this publication. An index is a great aid to impatient research workers. Present-time users of basic reference works demand a far higher standard of indexing than was considered adequate a half century ago. Modern reference works have responded to this insistent demand of scholars, libraries and general readers with greatly expanded useful indexes.

I am pleased to relinquish the editorship of the *Great Basin Naturalist* and in doing so wish the new editor, Dr. Stephen L.

[2]Book Notices. *Great Basin Naturalist*, Vol. 1, No. 1, Ann. Ent. Society America, 32(4): 779-780, Dec. 16, 1939. Also, Leech, Hugh B., Vasco M. Tanner, "A Lifetime with Beetles." *Great Basin Naturalist*, 30(4):215, Dec. 31, 1970.

Wood, professor of zoology and entomology, success in his new assignment. Dr. Wood has contributed many important papers to this journal, and he is well prepared to serve as editor.

This index should be of help to all who consult the first thirty volumes. It is divided into three parts, 1) author index; 2) subject index; 3) list of all new taxa described in the journal.

I would like to thank Mrs. Judy Stevens and Abe Panoke for assistance with typing and galley proofreading.

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Pedicia (*Pedicia*) *bellamyana* Alexander, n. sp. 24(3-4):117, 1964
Pedicia (*Tricyphona*) *ampla cinereicolor* Alexander, n. subsp. 18(1):32, 1958
Pedicia (*Tricyphona*) *ampla perangusta* Alexander, n. subsp. 18(1):33, 1958
Pedicia (*Tricyphona*) *aspidoptera convexa* Alexander, n. subsp. 18(1):33, 1958
Pedicia (*Tricyphona*) *hynesiana* Alexander, n. sp. 21(1-2):14, 1961
Pedicia (*Tricyphona*) *pahasapa* Alexander, n. sp. 18(1):31, 1958
Pedicia (*Tricyphona*) *shastensis* Alexander, n. sp. 18(1):35, 1958
Pedicia (*Tricyphona*) *steensensis* Alexander, n. sp. 18(1):33, 1958
Phyllolabis hurdi Alexander, n .sp. 24(3-4):119, 1964
Prionocera broweriana Alexander, n. sp. 21(4):79, 1961
Rhabdomastix (*Sacandaga*) *hynesi* Alexander, n. sp. 26(1-2):6, 1966
Rhabdomastix (*Sacandaga*) *neolurida flaviventris* Alexander, n. sp. 24(3-4):121, 1964
Shannonomyia semireducta Alexander, n. sp. 30(4):239, 1970
Thaumastoptera hynesi Alexander, n. sp. 24(1):20, 1964
Tipula (*Arctotipula*) *denali* Alexander, n. sp. 29(1):2, 1969
Tipula (*Arctotipula*) *epios* Alexander, n. sp. 29(1):3, 1969
Tipula (*Arctotipula*) *mckinleyana* Alexander, n. sp. 29(1):4, 1969
Tipula (*Arctotipula*) *sacra* Alexander, n. sp. 5(3-4):93, 1944
Tipula (*Arctotipula*) *smithae* Alexander, n. sp. 28(1):16, 1968
Tipula (*Bellardina*) *flinti* Alexander, n. sp. 30(4):236, 1970
Tipula (*Eremotipula*) *eurystyla* Alexander, n. sp. 29(1):8, 1969
Tipula (*Eumicrotipula*) *estella* Alexander, n. sp. 30(4):237, 1970
Tipula (*Hesperotipula*) *chumash* Alexander, n. sp. 21(1-2):13, 1961
Tipula (*Hesperotipula*) *linsdalei obispoensis* Alexander, n. subsp. 22(1-3):4, 1962
Tipula (*Lunatipula*) *cladacanthodes* Alexander, n. sp. 24(1):19, 1964
Tipula (*Lunatipula*) *grahamina* Alexander, n. sp. 23(3-4):162, 1963
Tipula (*Lunatipula*) *incisa picturata* Alexander, n. subsp. 21(4):84, 1961
Tipula (*Lunatipula*) *kirkwoodi* Alexander, n. sp. 21(4):82, 1961
Tipula (*Lunatipula*) *mecotrichia* Alexander, n. sp. 26(1-2):2, 1966
Tipula (*Lunatipula*) *mercedensis* Alexander, n. sp. 25(3-4):50, 1965
Tipula (*Lunatipula*) *productisterna* Alexander, n. sp. 23(3-4):164, 1963
Tipula (*Lunatipula*) *saylori* Alexander, n. sp. 21(4):81, 1961
Tipula (*Lunatipula*) *triplex integra* Alexander, n. subsp. 22(1-3):4, 1962
Tipula (*Nippotipula*) *metacomet* Alexander, n. sp. 25(3-4):49, 1965
Tipula (*Platytipula*) *knowltoniana* Alexander, n. sp. 29(1):5, 1969
Tipula (*Platytipula*) *paterifera* Alexander, n. sp. 22(1-3):2, 1962
Tipula (*Platytipula*) *perhirtipes* Alexander, n. sp. 23(3-4):162, 1963
Tipula (*Pterelachisus*) *horningi* Alexander, n. sp. 26(1-2):1, 1966
Tipula (*Pterelachisus*) *simondsi* Alexander, n. sp. 25(3-4):51, 1965
Tipula (*Sinotipula*) *denningi* Alexander, n. sp. 29(1):7, 1969
Tipula (*Trichotipula*) *dis* Alexander, n. sp. 22(1-3):1, 1962
Tipula (*Trichotipula*) *gertschi* Alexander, n. sp. 23(3-4):159, 1963
Tipula (*Trichotipula*) *hedgesi* Alexander, n. sp. 21(1-2):10, 1961
Tipula (*Yamatotipula*) *carsoni* Alexander, n. sp. 23(3-4):160, 1963
Tipula (*Yamatotipula*) *footeana* Alexander, n. sp. 21(1-2):11, 1961
Tipula (*Yamatotipula*) *toklatensis* Alexander, n. sp. 28(1):17, 1968

Zelandotipula serratimargo Alexander, n. sp. 30(4):233, 1970

DIPTERA: BLEPHAROCERIDAE

Bibiocephala nigripes Alexander, n. sp. 25(1-2):2, 1965

DIPTERA: DOLICHOPODIDAE

Aphrosylus wirthi Harmston, n. sp. 11(1-2):13, 1951
Argyra utahna Harmston, n. sp. 11(1-2):16, 1951
Chrysotus silvicolus Harmston, n. sp. 11(1-2):11, 1951
Medeterus arnaudi Harmston, n. sp. 11(1-2):12, 1951
Neurigona torrida Harmston, n. sp. 11(1-2):14, 1951
Syntormon californicum Harmston, n. sp. 11(1-2):15, 1951

DIPTERA: ASILIDAE

Cyrtopogon albifacies Johnson, n. sp. 3(1):1, 1942
Mallophora (*Mallophorina*) *pallida* Johnson, n. sp. 18(2):41, 1958

DIPTERA: PUPIPARA, NYCTERIBIIDAE

Basilia jellisoni Theodor and Peterson, n. sp. 24(3-4):109, 1964
Basilia mimoni Theodor and Peterson, n. sp. 24(3-4):107, 1964
Penicillidia godivae Theodor and Peterson, n. sp. 24(3-4):113, 1964

COLEOPTERA: CICINDELIDAE

Amblycheila utahensis Tanner, n. sp. 11(1-2):47, 1951

COLEOPTERA: CARABIDAE

Elaphrus torreyensis Tanner, n. sp. 2(4):137, 1941

COLEOPTERA: OMOPHRONIDAE

Homophron tanneri Chandler, n. sp. 2(2):100, 1941
Homophron tanneri proximum Chandler, n. subsp. 2(2):102, 1941

COLEOPTERA: DYTISCIDAE

Hydroporus transpunctatus Chandler, n. sp. 2(2):103, 1941

COLEOPTERA: CLERIDAE

Enoclerus eximius trullionis Barr, n. subsp. 7(1-4):21, 1946

COLEOPTERA: BUPRESTIDAE

Acmaeodera diffusa Barr, n. sp. 29(1):13, 1969

COLEOPTERA: TENEBRIONIDAE

Araeoschizus airmeti Tanner, n. sp. 6(1-4):125, 1945
Craniotus blaisdelli Tanner, n. sp. 23(3-4):169, 1963
Eleodes inyoensis Tanner, n. sp. 21(3):68, 1961
Eleodes leechi Tanner, n. sp. 21(3):63, 1961
Eschatomoxys tanneri Sorenson and Stones, n. sp. 19(2-3):63, 1959

COLEOPTERA: SCARABAEIDAE

Diplotaxis aconomicus Cazier, n. sp. 1(3-4):131, 1940
Diplotaxis aequalis Cazier, n. sp. 1(3-4):129, 1940
Diplotaxis aulacochela Cazier, n. sp. 1(3-4):131, 1940
Diplotaxis brevicornis Cazier, n. sp. 1(3-4):136, 1940
Diplotaxis fulgida Cazier, n. sp. 1(3-4):130, 1940
Diplotaxis impressifrons Cazier, n. sp. 1(3-4):127, 1940
Diplotaxis microps Cazier, n. sp. 1(3-4):134, 1940
Diplotaxis parkeri Cazier, n. sp. 1(3-4):133, 1940
Diplotaxis persisae Cazier, n. sp. 1(3-4):133, 1940
Diplotaxis recticanthus Cazier, n. sp. 1(3-4):135, 1940
Diplotaxis saylori Cazier, n. sp. 1(3-4):128, 1940
Diplotaxis ungulatus Cazier, n. sp. 1(3-4):132, 1940

COLEOPTERA: CURCULIONIDAE

Bagous angustus Tanner, n. sp. 14(3-4):73, 1954
Bagous blatchleyi Tanner, n. sp. 4(1-2):14, 1943
Bagous chandleri Tanner, n. sp. 4(1-2):26, 1943
Bagous dietzi Tanner, n. sp. 14(3-4):74, 1954
Bagous floridanus Tanner, n. sp. 4(1-2):30, 1943
Bagous lengi Tanner, n. sp. 4(1-2):13, 1943
Bagous longirostrus Tanner, n. sp. 4(1-2):18, 1943
Bagous texanus Tanner, n. sp. 4(1-2):20, 1943
Bagous tingi Tanner, n. sp. 4(1-2):27, 1943
Cimbocera petersoni Tanner, n. sp. 2(1):29, 1941
Dorytomus rubidus Tanner, n. sp. 1(1):32, 1939
Eucyllus tinkhami Tanner, n. sp. 19(2-3):53, 1959
Eupagoderes hardyi Tanner, n. sp. 1(1):31, 1939
Eupagoderes utahensis Tanner, n. sp. 1(1):31, 1939
Lophothetes reimschiisseli Tanner, n. sp. 20(1-2):26, 1960
Miloderoides vandykei Tanner, n. sp. 3(1):23, 1942
Moluccobius marshalli Tanner, n. sp. 20(1-2):23, 1960
Onychylis essigi Tanner, n. sp. 14(3-4):77, 1954
Pandeleteius bryanti Tanner, n. sp. 14(3-4)):76, 1954
Pnigodes buchanani Tanner, n. sp. 4(1-2):33, 1943
Pnigodes tuberosus Tanner, n. sp. 4(1-2):35, 1943
Pseudoeucyllus boulderensis Tanner, n. sp. 10(1-4):71, 1950

COLEOPTERA: PLATYPODIDAE

Cenocephalus epistomalis Wood, n. sp. 26(3-4):47, 1966
Neotrachyostus obliquus Wood, n. sp. 26(3-4):49, 1966
Platypus abditulus Wood, n. sp. 26(3-4):50, 1966
Platypus abietis Wood, n. sp. 18(1):39, 1958
Platypus angustatulus Wood, n. sp. 26(3-4):55, 1966
Platypus annexus Wood, n. sp. 26(3-4):62, 1966
Platypus brevicornis Wood, n. sp. 26(3-4):61, 1966
Platypus chiriquensis Wood, n. sp. 26(3-4):59, 1966
Platypus clunalis Wood, n. sp. 26(3-4):67, 1966
Platypus cluniculus Wood, n. sp. 26(3-4):69, 1966
Platypus clunis Wood, n. sp. 26(3-4):68, 1966
Platypus connexus Wood, n. sp. 26(3-4):65, 1966
Platypus eugestus Wood, n. sp. 26(3-4):64, 1966
Platypus exitialis Wood, n. sp. 26(3-4):51, 1966
Platypus liraticus Wood, n. sp. 26(3-4):58, 1966
Platypus longior Wood, n. sp. 26(3-4):56, 1966
Platypus longius Wood, n. sp. 26(3-4):57, 1966
Platypus occipitis Wood, n. sp. 26(3-4):54, 1966
Platypus prenexus Wood, n. sp. 26(3-4):64, 1966

Platypus schedli Wood, n. sp. 26(3-4):51, 1966
Platypus senexus Wood, n. sp. 26(3-4):66, 1966
Platypus simpliciformis Wood, n. sp. 26(3-4):57, 1966
Platypus vegestus Wood, n. sp. 26(3-4):63, 1966
Tesserocerus forceps Wood, n. sp. 26(3-4):46, 1966

COLEOPTERA: SCOLYTIDAE

Amphicranus quercus Wood, n. sp. 27(1):53, 1967
Amphicranus rameus Wood, n. sp. 27(1):55, 1967
Aphanocleptus coniferae Wood, n. sp. 20(3-4):64, 1960
Bothrosternus definitus Wood, n. sp. 28(2):109, 1968
Brachyspartus emarginatus (Eggers), n. comb. 26(1-2):22, 1966
Cactopinus cactophthorus Wood, n. sp. 17(3-4):105, 1957
Cactopinus mexicanus Wood, n. sp. 27(1):37, 1967
Cactopinus spinatus Wood, n. sp. 17(3-4):106, 1957
Carphoborus perplexus Wood, n. sp. 20(3-4):59, 1960
Chaetophloeus minimus Wood, n. sp. 27(2):95, 1967
Chaetophloeus struthanthi Wood, n. sp. 27(2):96, 1967
Chramesus bicolor Wood, n. sp. 27(2):91, 1967
Chramesus demissus Wood, n. sp. 27(2):93, 1967
Chramesus incomptus Wood, n. sp. 27((2):90, 1967
Chramesus minulus Wood, n. sp. 29(3):126, 1969
Chramesus punctatus Wood, n. sp. 27(2):94, 1967
Chramesus setosus Wood, n. sp. 20(3-4):61, 1960
Chramesus strigatus Wood, n. n. 20(3-4):62, 1960
Chramesus vastus Wood, n. sp. 27(2):92, 1967
Chramesus vitiosus Wood, n. sp. 29(3):125, 1969
Cnesinus adusticus Wood, n. sp. 27(2):87, 1967
Cnesinus annectens Wood, n. sp. 27(2):86, 1967
Cnesinus atavus Wood, n. sp. 28(2):106, 1968
Cnesinus atrodeclivis Wood, n. sp. 28(2):108, 1968
Cnesinus bicornus Wood, n. sp. 27(2):80, 1967
Cnesinus carinatus Wood, n. sp. 27(2):88, 1967
Cnesinus colombianus Wood, n. sp. 27(2):84, 1967
Cnesinus degener Wood, n. sp. 28(2):105, 1968
Cnesinus denotatus Wood, n. sp. 28(2):107, 1968
Cnesinus electinus Wood, n. sp. 27(2):82, 1967
Cnesinus elegantis Wood, n. sp. 27(2):79, 1967
Cnesinus foratus Wood, n. sp. 27(2):81, 1967
Cnesinus frontalis Wood, n. sp. 28(2):104, 1968
Cnesinus gibbosus Wood, n. sp. 28(2):101, 1968
Cnesinus gibbulus Wood, n. sp.. 28(2):100, 1968
Cnesinus minitropis Wood, n. sp. 28(2);105, 1968
Cnesinus myelitis Wood, n. sp. 27(2):84, 1967
Cnesinus niger Wood, n. sp. 27(2):83, 1967
Cnesinus perplexus Wood, n. sp. 28(2):102, 1968
Cnesinus retifer Wood, n. sp. 27(2):85, 1967
Cnesinus squamosus Wood, n. sp. 28(2):102, 1968
Conophthorus mexicanus Wood, n. sp. 22(1-3):79, 1962
Corthylus petilus Wood, n. sp. 27(1):56, 1967
Corthylus splendens Wood, n. sp. 27(3):138, 1967
Cryphalomorphus expers (Blandford), n. comb. 26(1-2):22, 1966
Cryptulocleptus Wood, n. n. 22(1-3):76, 1962
Dactylipalpus unctus Wood, n. sp. 21(1-2):8, 1961
Dendrocranulus schedli Wood, n. n. 26(1-2):23, 1966
Dendroctonus aztecus Wood, n. sp. 23(1-2):69, 1963
Dendroterus confinis Wood, n. sp. 19(1):6, 1959
Dendroterus decipiens Wood, n. sp. 19(1):5, 1959
Dendroterus mundus Wood, n. sp. 19(1):3, 1959
Dendroterus texanus Wood, n. sp. 19(1):4, 1959

Dryotomicus Wood, n. n. 22(1-3):76, 1962
Eupagiocerus clarus Wood, n. sp. 25(1-2):33, 1965
Eupagiocerus serratus Wood, n. sp. 21(4):104, 1961
Eupagiocerus vastus Wood, n. sp. 25(1-2):34, 1965
Gnathophthorus Wood, n. n. 22(1-3):76, 1962
Gnathotrichus dentatus Wood, n. sp. 27(1):45, 1967
Gnathotrichus imitans Wood, n. sp. 27(1):48, 1967
Gnathotrichus nimifrons Wood, n. sp. 27(1):47, 1967
Gnathotrichus perniciosus Wood, n. sp. 27(1):47, 1967
Gnathotrupes fimbriatus (Schedl), n. comb. 26(1-2):23, 1966
Gnathotrypanus electus Wood, n. sp. 28(1):10, 1968
Gnathotrypanus terebratus Wood, n. sp. 28(1):9, 1968
Hexacolus multistriatus Wood, n. sp. 21(4):97, 1961
Hexacolus obscurus Wood, n. sp. 21(4):100, 1961
Hexacolus reticulatus Wood, n. sp. 21(4):98, 1961
Hexacolus tenuis Wood, n. sp. 21(4):99, 1961
Hoplitontus Wood, n. n. 21(1-2):2, 1961
Hoplitophthorus Wood, corrected spelling 21(4):105, 1961
Hoplitophthorus boliviae Wood, n. sp. 21(4):106, 1961
Hoplitophthorus cubensis Wood, n. sp. 21(4):107, 1961
Hoplitophthorus major (Eggers), n. comb. 21(4):105, 1961
Hoplitophthorus sentus Wood, n. sp. 21(1-2):3, 1961
Hylastes flohri (Eggers), n. comb. 26(1-2):24, 1966
Hylastes mexicanus Wood, n. sp. 27(1):36, 1967
Hylocurus femineus Wood, n. sp. 19(2-3):59, 1959
Hylocurus hirtellus (LeConte), n. comb. 26(1-2):24, 1966
Hylocurus minor Wood, n. sp. 21(1-2):4, 1961
Ips sabinianae (Hopping), n. comb. 28(1):15, 1968
Ips sulcifrons Wood, n. sp. 20(3-4):67, 1960
Ips utahensis Wood, n. sp. 20(3-4):66, 1960
Leperisinus guatemalensis Wood, n. sp. 27(2):89, 1967
Liparthrum arizonicum Wood, n. sp. 19(2-3):57, 1959
Loganius confinis Wood, n. sp. 21(4):94, 1961
Loganius exilis Wood, n. sp. 27(3):119, 1967
Loganius fastigius Wood, n. sp. 21(4):93, 1961
Loganius impressus Wood, n. sp. 21(4):90, 1961
Loganius liratus Wood, n. sp. 21(4):92, 1961
Loganius niger Wood, n. sp. 21(4):95, 1961
Loganius prociduus Wood, n. sp. 21(4):91, 1961
Loganius splendens Wood, n. sp. 21(4):88, 1961
Loganius vagabundus Wood, n. sp. 21(4):89, 1961
Micracis carinulatus Wood, n. sp. 20(3-4):62, 1960
Microcorthylus desus Wood, n. sp. 27(1):52, 1967
Microborus camerunus (Eggers), n. comb. 21(4):101, 1961
Microborus lautus Wood, n. sp. 21(4):101, 1961
Mimips chiriquensis (Blanford), n. comb. 26(1-2):24, 1966
Monarthrum bicavum Wood, n. sp 27(1):51, 1967
Monarthrum bicolor Wood, n. sp. 28(1):4, 1968
Monarthrum bisetosum (Schedl), n. comb. 26(1-2):24, 1966
Monarthrum exornatum (Schedl), n. comb. 26(1-2):25, 1966
Monarthrum huachucae Wood, n. sp. 19(2-3):61, 1959
Monarthrum laterale (Eichhoff), n. comb. 26(1-2):25, 1966
Monarthrum melanura Blanford, n. comb. 26(1-2):26, 1966
Monarthrum preclarus Wood, n. sp. 28(1):6, 1968
Monarthrum quercicolens Wood, n. sp. 27(1):49, 1967
Monarthrum querneus Wood, n. sp. 27(1)50, 1967
Neodryocoetes limbatus (Eggers), n. comb. 26(1-2):27, 1966
Paracorthylus velutinus Wood, n. sp. 28(1):7, 1968
Pityoborus hirtellus Wood, n. sp. 18(2):50, 1958
Pityoborus intonsus Wood, n. sp. 18(2):54, 1958
Pityoborus rubentis Wood, n. sp. 18(2):51, 1958
Pityoborus velutinus Wood, n. sp. 18(2):48, 1958

Pityokteines ornatus (Swaine), n. comb. 26(1-2):27, 1966
Pityophthorus abiegnus Wood, n. sp. 24(2):67, 1964
Pityophthorus atomus Wood, n. sp. 24((2):61, 1964
Pityophthorus borrichiae Wood, n. sp. 24(2):60, 1964
Pityophthorus cristatus Wood, n. sp. 24(2):68, 1964
Pityophthorus dolus Wood, n. sp. 24(2):65, 1964
Pityophthorus elatinus Wood, n. sp. 24(2):66, 1964
Pityophthorus festus Wood, n. sp. 27(1):39, 1967
Pityophthorus foratus Wood, n. sp. 27(1):40, 1967
Pityophthorus hylocuroides Wood, n. sp. 24(2):69, 1964
Pityophthorus islasi Wood, n. sp. 22(1-3):80, 1962
Pityophthorus limatus Wood, n. sp. 24(2):65, 1964
Pityophthorus nanus Wood, n. sp. 24(2):64, 1964
Pityophthorus paulus Wood, n. sp. 24(2):63, 1964
Pityophthorus pusillus Wood, n. sp. 24(2):62, 1964
Pityophthorus quercinus Wood, n. sp. 27(1):40, 1967
Pityophthorus schwerdtfergeri (Schedl), n. comb. 26(1-2):28, 1966
Pityophthorus toralis Wood, n. sp. 24(2):59, 1964
Pityotrichus Wood, n. n. 22(1-3):76, 1962
Phloeotribus destructor Wood, n. sp. 29(3):123, 1969
Phloeotribus furvus Wood, n. sp. 29(3):124, 1969
Phloeotribus quercinus Wood, n. sp 29(3):123, 1969
Phloeotribus simplex Wood, n. sp. 27(2):95, 1967
Prionosceles glaber Wood, n. sp. 21(4):102, 1961
Prionosceles panamensis Wood, n. sp. 21(4):103, 1961
Pseudohylesinus pini Wood, n. sp. 29(3):122, 1969
Pseudothysanoes thomasi Wood, n. sp. 27(1):38, 1967
Pseudopityophthorus granulifer Wood, n. sp. 27(1):42, 1967
Pseudopityophthorus hondurensis Wood, n. sp. 27(1)42, 1967
Pseudopityophthorus micans Wood, n. sp. 27(1):44, 1967
Pseudopityophthorus tenuis Wood, n. sp. 19(1):1, 1959
Pseudopityophthorus tropicalis Wood, n. sp. 27(1):43, 1967
Pseudothysanoes multispinatus Wood, n. sp. 17(3-4):109, 1957
Pseudothysanoes spinura Wood, n. sp. 19(2-3):58, 1959
Pseudothysanoes tresmariae (Schedl), n. comb. 26(1-2):29, 1966
Scolytodes amoenus Wood, n. sp. 27(3):128, 1967
Scolytodes clusiacolens Wood, n. sp. 27(3):121, 1967
Scolytodes clusiavorus Wood, n. sp. 27(3):122, 1967
Scolytodes facetus Wood, n. sp. 27(3):126, 1967
Scolytodes ficivorus Wood, n. sp. 27(3):125, 1967
Scolytodes ingavorus Wood, n. sp. 27(3):126, 1967
Scolytodes nanellus Wood, n. sp. 27(3):124, 1967
Scolytodes perditus Wood, n. sp. 27(3):123, 1967
Scolytodes proximus Wood, n. sp. 27(3):127, 1967
Scolytodes venustulus Wood, n. sp. 27(3):124, 1967
Scolytopsis cubensis Wood, n. sp. 21(4):87, 1961
Scolytopsis laticollis Wood, n. sp. 28(1):14, 1968
Scolytus aztecus Wood, n. sp. 27(3):120, 1967
Scolytus hermosus Wood, n. sp. 28(1):12, 1968
Scolytus mundus Wood, n. sp. 28(1):13, 1968
Scolytus obelus Wood, n. sp. 22(1-3):81, 1962
Spermatophthorus aberrans Wood, n. sp. 28(1):11, 1968
Stegomerus chiriquensis Wood, n. sp. 27(3):131, 1967
Stegomerus mexicanus Wood, n. sp. 27(3):133, 1967
Stegomerus montanus Wood, n. sp. 27(3):132, 1967
Stegomerus pygmaeus Wood, n. sp. 27(3):130, 1967
Stegomerus vulgaris Wood, n. sp. 27(3):134, 1967
Styracoptinus Wood, n. n. 22(1-3):76, 1962
Thamnophthorus impensus Wood, n. sp. 21(1-2):6, 1961
Toxophthorus Wood, n. n. 22(1-3):76, 1962
Tricolus saundersi Wood, n. sp. 27(3):139, 1967
Tricolus spectibilis Wood, n. sp. 27(3):140, 1967

Xyleborus bicornatulus Wood, n. sp. 27(3):137, 1967
Xyleborus horridatus Wood, n. sp. 27(3):135, 1967
Xyleborus horridicus Wood, n. sp. 27(3):136, 1967
Xyleborus longideclivis Wood, n. sp. 28(1):1, 1968
Xyleborus parcellus Wood, n. sp. 28(1):2, 1968
Xyleborus usticius Wood, n. sp. 28(1):3. 1968
Xylosandrus zimmermanni (Hopkins), n. comb. 26(1-2):33, 1966

SIPHONAPTERA: HYSTRICHOPSYLLIDAE

Megarthroglossus becki Tipton and Allred, n. sp. 11(3-4):108. 1951

HYMENOPTERA: FORMICIDAE

Aphaenogaster (*Attomyrma*) *boulderensis* Smith, n. sp. 2(3):120, 1941
Aphaenogaster (*Attomyrma*) *floridana* Smith, n. sp. 2(3):118, 1941
Myrmecocystus pyramicus Smith, n. sp. 11(3-4):91, 1951
Veromessor lariversi Smith, n. sp. 11(3-4):94, 1951

ACARINA: TROMBICULIDAE

Acomatacarus sexacis Allred and Beck, n. sp. 13(3-4):87, 1953
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ON TWO SPECIES OF FALSE MORELS (*GYROMITRA*) IN UTAH

Kent H. McKnight[1]

The "Giant Helvella," *Gyromitra gigas* (Krombh.) Quél., is well known to collectors of spring mushrooms at high elevations in the Rocky Mountains. Although there are conflicting claims regarding its edibility, it is often collected for food. Study of dried specimens in various herbaria throughout North America and some from Europe, as well as numerous fresh collections from the United States, reveal two different species that are commonly called *Gyromitra gigas*. The second species is here referred to as *Gyromitra fastigiata* (Krombh.) Rehm. Although the two may look alike macroscopically, they are readily distinguishable on spore characteristics, with *G. fastigiata* having broadly fusiform spores with well-developed apiculi. *Gyromitra gigas* has more elliptic spores with little or no apiculi. The two North American species fit quite well the descriptions given by Krombholz (1832) for his two species of *Helvella*. Since there appear to be no holotypes extant, final disposition of these two entities must await their more critical study in central Europe where the one which Krombholz called *H. gigas* appears to be uncommon. Detailed descriptions follow for the two species, based on study of fresh collections as well as specimens from herbaria listed below. Differences between *G. gigas* and *G. fastigiata* and other species with which they are confused will be explored. Loans or use of facilities by the following institutions are gratefully acknowledged: Botanical Department of the National Museum, Prague (PR); Brigham Young University (BRY); Colorado State University (CS); Cornell University (CUP); Forest Disease Laboratory, U.S. Forest Service, Laurel, Md. (BFDL); Harvard University (FH); Institut für Spezielle Botanik der Eidg. Technischen Hoschschulle, Zurich (ZT); Naturhistorische Museum, Vienna (W); New York Botanical Garden (NY); Oregon State University (OSC); Plant Research Institute, Canada Department of Agriculture, Ottawa (DAOM); San Francisco State College (SF); University of Michigan (MICH); University of Tennessee (TENN);

[1]Plant Science Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Maryland 20705.

and the University of Toronto (TRTC). Color names in small caps follow Kelly and Judd (1955).

Gyromitra fastigiata (Krombh.) Rehm.

Fig. 1

Gyromitra fastigiata (Krombh.) Rehm. 1896. Die Pilze *in* Rabenh., L. Krypt.-Fl. Deutschl., Oster., Schw. 2nd Ed. 1:1194.

Ascocarp stipitate, shape irregular but roughly globose to ellipsoid, 3.5-9.0 cm in diameter, receptacle everted, wrinkled to convoluted and lobed, outer surface adnate with the stipe and in places intergrown with it, 0.5-2.0 mm thick, hymenium DARK GRAYISH YELLOW (2.5Y 6/5) to STRONG YELLOWISH BROWN (10YR 5/6), STRONG BROWN (7.5YR 4/6), or MODERATE BROWN (7.5YR 4/5 to 6YR 3/4); excipulum white. Odor and taste not distinctive. Stipe thick and fleshy, hollow with several anastomosing channels, even or expanded downward, 1.5-5.0 x 2.5-8.0 cm, longitudinally ribbed with rounded ribs, surface white or nearly so, glabrous to minutely furfuraceous.

In section, hymenium 350-450 μ thick; subhymenium indistinct, 100-150 μ broad, consisting of textura intricata having protoplasm which stains dark in lactofuchsin and in cotton blue and including scattered oleiferous hyphae; medullary excipulum indistinctly 2-layered, the upper layer, 200-250 μ thick, of compact textura intricata, gradually becoming less compact outward, the lower, less compact layer 800-1200 μ thick, of very loose textura intricata; ectal excipulum 2-layered, the inner layer 170-200 μ thick, consisting of compact, much interwoven textura intricata, the outer layer, 75-95 μ thick, consisting of loose, radially oriented textura intricata tending to textura porrecta, hyphae 8-15 μ in diameter, terminal cells variable in shape, clavate to cylindrical or ventricose and sometimes capitate; conspicuous oleiferous hyphal segments scattered through subhymenium and medullary excipulum. Asci cylindric, contorted and tapered gradually at the base, 360-415 x 14-20 μ, J-, protoplasm of young asci STRONG ORANGE YELLOW (near 7.5YR 7/12) in Melzer's solution. Ascospores fusiform to narrowly elliptic, flattened in one view, hyaline, typically with one large central guttule and two smaller terminal guttules, apiculate, smooth at first but soon ornamented with a very faint to distinct, low, complete reticulum of narrow, closely spaced ridges, (21) 23.5-32.0 x 10-14 μ, apiculi truncate to broadly rounded, 1-3 μ long. Paraphyses tips cylindric to clavate, sometimes tending to be capitate, dull ochraceous brown in H_2O, fading rapidly to dull grayish yellow in KOH, darker (dull ochraceous brown) on dried specimens revived in KOH, BRIGHT YELLOW (2.5Y 8.5/6) when revived in Melzer's solution, 7-12 μ across at apex, 4.0-5.5 μ in diameter below.

HABIT, HABITAT, AND DISTRIBUTION.—Solitary to gregarious; on soil in hardwood or mixed hardwood-conifer forests, in valleys or lowlands; Atlantic Seaboard to Utah, Oregon, Idaho, and Washington.

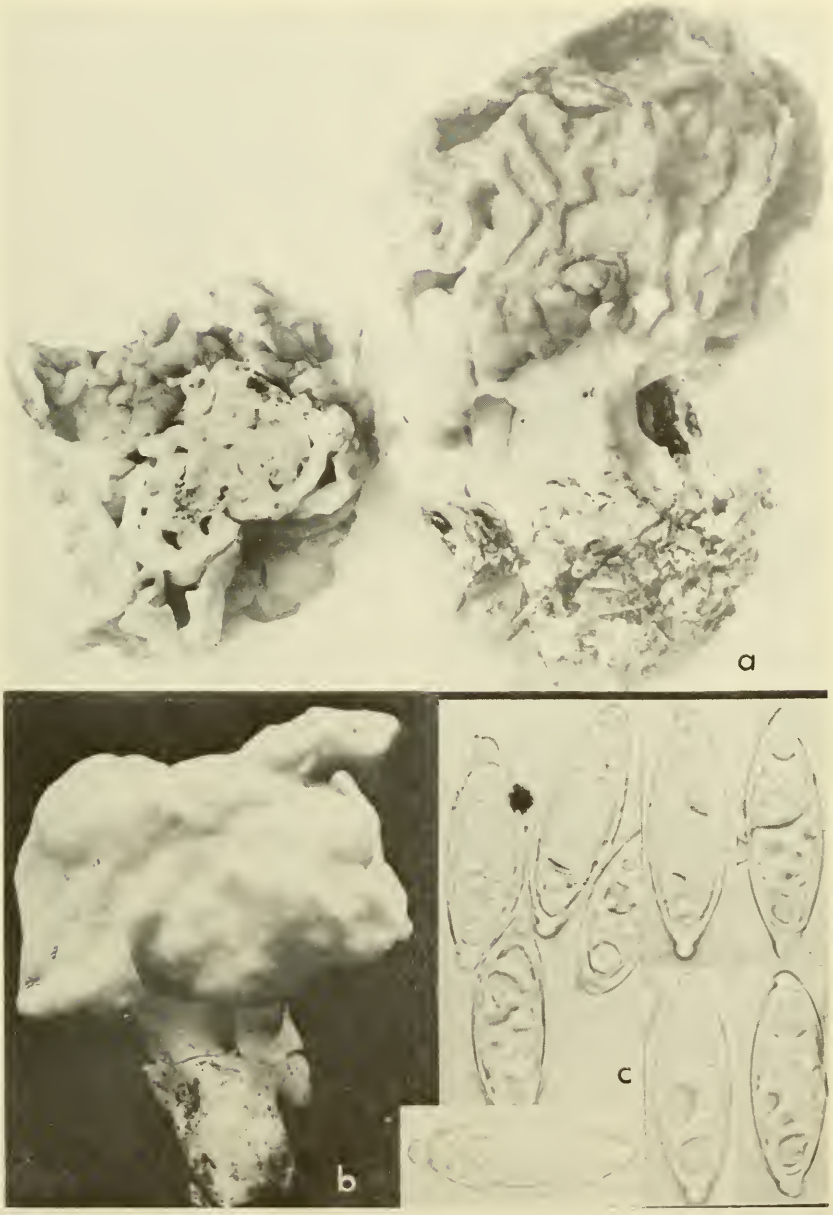

Fig. 1. *Gyromitra fastigiata,* apothecia and ascospores. a, b. apothecia, X ½. c. ascospores, X 1,000.

COLLECTIONS STUDIED.—CANADA: ONTARIO: Bell 17.V.1931, 7.V.1933 (TRTC), Elliott 61-53, 61-54, Groves 22.IV.1953, Horner 3.V.1953, Odell 30.V.1929, Savile and Parmelee 29.IV.1955 (DAOM). QUEBEC: Dupret-Lloyd 32476 (BPI), Hoare 3.V.1953, Horner 17.V.1954 (DAOM). CZECHOSLOVAKIA: Charvat IV.1943 (PR), v. Höhnel A5909 (FH), Kotlaba 10.V.1970, Landkammer 21.IV.1944, Svrcek 19.III.1961, 3.IV.1966 (PR). FINLAND: Karsten 721 (BPI and CUP). FRANCE: Patouillard 4858 (FH). SWEDEN: Lund. and Nannf. Exs. 1353 (BPI and PR), Melderis 15.V.1946, 13.V.1949 (DAOM), Romell 25.V.1896 (CUP). SWITZERLAND: Horak 2.VI.1964 (ZT and BPI), J. Peter 16.VI.1965 (ZT). UNITED STATES: IDAHO: Grand 17.V.1967 (TRTC), Wehmeyer 23.VI.1920 (MICH). KENTUCKY: Fink 10745 (CUP). MARYLAND: Blevins 13.VI.1935, Cash 14.IV.1935, Lakin-Lloyd 15161, McKnight 11727 (BPI), Miller 8274, 8275 (BFDL and BPI). MASSACHUSETTS: Thaxter 624 (FH). NEW YORK: Atkinson V.1901, Coppellini 21.V.1953, Korf 2628, 43900, McCaughy 4.V.1905 (CUP), McKnight 10766 (BPI), Peck-CUP 5-21, Peck-CUP 5-22, Peck-CUP 5-23, Petry 537, Reddick 5.V.1907 (CUP). NORTH CAROLINA: Whetzel, et al. 5.IV.1940 (CUP). OHIO: Walters 1942 (NY). OREGON: Denison 3299 (OSC). UTAH: Rhoads 24.VI.1945 (BPI). VIRGINIA: Yechelson 29.III.1930, McKnight 10722, Schlatter 12.IV.1925 (BPI). WEST VIRGINIA: Nuttall 11.IV.1895 (CUP).

OBSERVATIONS.—A distinctive characteristic of the species is its broadly fusiform, 1- to 3-guttulate spores having well-developed apiculi which are truncate to broadly rounded at the apex (Fig. 1c).

Gyromitra gigas (Krombh.) Quél.

Fig. 2

Gyromitra gigas (Krombh.) Quél. 1873. Champ. Jura Vosg. 2. *In* Mém. Soc. Emul. Montbéliard Ser. II, 5:338.

Ascocarp stipitate, irregular in shape but roughly globose to ellipsoid, (1x5) 5-18 cm across, receptacle everted, strongly convolute with outer surface appressed against the stipe and sometimes interwoven with it, 1.5-2.5 mm thick; hymenium STRONG YELLOWISH BROWN (near 7.5YR 5/6) to STRONG BROWN (7.5YR 4/6) or MODERATE BROWN (7.5YR 4/4); excipulum white or nearly so. Odor and taste not distinctive. Stipe thick and fleshy, hollow with several anastomosing channels, even or expanded toward the base, 2-14 x 3-15 cm, longitudinally ribbed with rounded ribs, surface white or nearly so.

In section, hymenium 380-450 μ thick; subhymenium indistinctly differentiated from medullary excipulum, 150-200 μ broad, consisting of compact textura intricata and containing numerous oleiferous hyphae; medullary excipulum 650-750 μ thick, of textura intricata which is progressively more compact toward the subhymenium and less compact toward the ectal excipulum, hyphae 7-13 μ in diameter; ectal excipulum poorly differentiated, 150-250 μ thick, consisting of an outer layer about 80-100 μ broad, of filamentous cells (textura por-

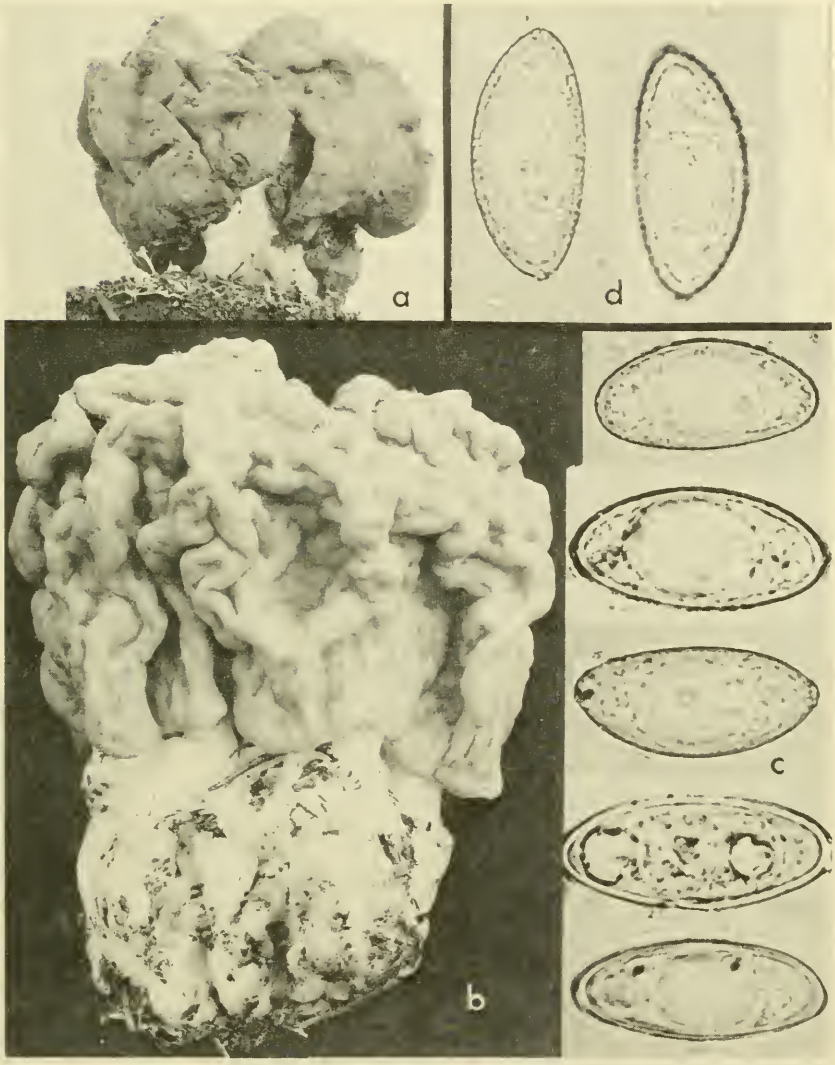

Fig. 2. *Gyromitra gigas*, apothecia and ascospores. a, b. apothecia, X ½. c. ascospores, X 1,000. d. the same ascospores at two levels of focus, X 1,000.

recta) and a more compact inner layer tending toward textura angularis about 100-150 μ broad, terminal cells clavate, 5.5-8.0 x 23-28 μ. The outer layer is visible only around the margin, as it soon becomes crushed and partially or wholly eroded away. Asci cylindric, contorted at the base, 350-400 x 18-24 μ, J-, young asci and immature spores STRONG ORANGE YELLOW (near 7.5YR 7/12) in Melzer's solution. Ascospores hyaline, eliptic, typically flattened on one side,

1-3 guttulate, smooth or very faintly roughened with an incomplete reticulum, (21.4) 24.3-35.8 (37.5) x (9) 10.7-15.8 μ, apiculus very short and truncate or more often broadly rounded, or lacking, 0-1.1 μ long. Paraphyses 2-4 septate above the branches, terminal cell cylindric-capitate, contorted, 4-12 μ across, PALE YELLOW (5Y 8.5/4) in Melzer's.

HABIT, HABITAT, AND DISTRIBUTION.—Solitary to gregarious, in early spring, on soil in conifer or mixed forests from the Rocky Mountains to the West Coast in North America, apparently rare in Europe, often found around melting snowbanks and sometimes developing to considerable size under the snow.

COLLECTIONS STUDIED.—AUSTRIA: Melzer 30.IV.1967 (W). CANADA: BRITISH COLUMBIA: Melburn 663 (DAOM). UNITED STATES: CALIFORNIA: Breckon 425 (SF), Burdick (NY), Copeland 18.VI.1938 (BPI and FH), 10.VII.1938 (TRTC), VI.1951 (BPI and MICH), Hanks 31.V.1964 (SF), Norman 5.V.1933 (BPI and FH), Sundberg 525, Thiers 11202, 16572, 16736, 16902, 19326, 19346, 19429, 19499, 19574, 19747, 19881, 19955 (SF). COLORADO: Overholts 1829 (BPI and NY), Overholts, Loch Vale, 1924 (NY). IDAHO: Largent 410, Smith 65130 (SF), Wehmeyer 23.VI.1920 (MICH), Weir 8123 (BPI, CUP, and NY). MONTANA: Weir 4774 (BPI). OREGON: Denison 3423, 3679, 3686, 3691 (OSC), Shaw, Baker, Ore., Whitead, Ashland, Ore. (NY), Weir 4771 (BPI). UTAH: Dublin 2615, McKnight F258, F342, F5173, F5189, F5211, F5237, F6472 (BRY), 11784, 11845, 11864, 11866, 11867, 11900, 11903, 11915, 11960 (BPI). WYOMING: McKnight 10128, 10183, 10338, 10350, 10351, 10352 (BPI), Peterson 47-60 (BPI and CS), Solheim and Cronin 2829 (BPI and DAOM).

OBSERVATIONS.—Spore shape distinguishes this species readily from *G. fastigiata*. Spores of *G. fastigiata* taper more toward the ends and have elongated, narrow apiculi giving them a distinctly fusiform shape (Fig. 1c), while those of *G. gigas* have shorter, more rounded apiculi or none at all, resulting in a wider ellipsoid to oval shape (Fig. 2c). In some cases there is no evidence of an apiculus in *G. gigas*, while in others the only suggestion of an apiculus is a slightly thickened wall at one or both ends of the spore. Rarely the apiculus is truncate and depressed as in *Discina leucoxantha* Bres.; but in all cases, when present, it is much broader than in *G. fastigiata*. The habit of fruiting under or near melting snowbanks may be significant in distinguishing the two species also.

DISCUSSION

In a single publication (1832) Krombholz described five new species of *Helvella* that apparently belong in *Gyromitra* Fr. (sensu Harmaja, 1969). He distinguished between them largely on characters of gross morphology and color of the ascocarp so that it has been very difficult for later workers to apply his names accurately to the species they find. However, with *G. gigas* and probably also with *G. fastigiata* he did give sufficient microscopic details for correct

identification, but it appears that quite generally the names have been applied incorrectly.

Krombholz stated that both species were found in the vicinity of Prague in early springtime. His descriptions specify a distinct difference in spore shape, as he described the spores of *G. gigas* as "gross und volkommen oval," whereas spores of *G. fastigiata* are said to be "elliptisch-spindelformig." He did not illustrate the microscopic characters of *G. fastigiata* and his drawings of *G. gigas*, by themselves, are ambiguous since fine details of spore structure are not shown and since he shows both 1- and 2-guttulate ascospores. Most of the spores are shown with broadly rounded apices, although some are more or less pointed. It should be noted, however, that at the magnification used details of surface patterns and apiculus might not be discernible unless the original drawings were more accurate than those of Krombholz apparently were. No mention is made of an apiculus on spores of either species. However, if apiculi were included in the description of spore shape, it would make the spores more nearly fusiform as Krombholz gives for the spore shape of *G. fastigiata*, rather than the oval shape he described for spores of *gigas*. The fact that he mentioned the 3-guttulate spores in *G. fastigiata* (and in this species only) clearly identifies it as a member of the *caroliniana-gigas* complex and refutes a possible identity with *G. esculenta* (Pers.) Fr. This, together with the brief descriptions of spore shape in the two species cited above, convinces me that the species with more definitely fusiform spores having longer apiculi should be called *fastigiata*, although it is commonly known as *gigas* both in Europe and in America. Just how the epithet *gigas* came to be associated with a species having fusiform spores with well-developed apiculi is not clear, but Krombholz's mention of brownish ascus tips and a taste of fresh almonds for *G. fastigiata* may have discouraged use of this name for the common European species. Both his description and illustrations indicate a tricuspidate-lobed receptable which may not be consistently apparent. His reference to Flora Danica Plate 116 (Oeder, et al., 1766-1883) and his suggestion of a close relationship to *Gyromitra infula* (Schaeff. ex Fr.) Quél. may have encouraged the idea that *G. fastigiata* was a synonym of *G. esculenta* in spite of his description of 3-guttulate spores for *G. fastigiata*. Fresh specimens referable to this species, which I have studied, have no taste and I have not seen brownish ascus tips in any of the collections studied; however, if there is a European species in this complex having these characters and a consistently fastigiate form, then perhaps the American species, which lacks them, should have a new name. Until this is confirmed, however, I prefer to use Krombholz's species names as indicated above.

Quélet (1873) transferred *Helvella gigas* Krombh. to the genus *Gyromitra* Fr., giving no illustrations and such an incomplete description, based on macroscopic characters, that no one can be certain what species he had in mind. However, in his very brief synopsis of the genus he states, "Spore ovale, bi-ocellée." Later (1886) he listed *G. curtipes* Fr. as a synonym of *G. gigas*. Although, at the

time he transferred *H. fastigiata* Krombh. to *Gyromitra*, he recognized both species, Rehm (1896) illustrated the spores of *G. gigas* with narrow, pointed apices and described them as "breit spindelförmig," which is very nearly identical with Krombholz's description of the spores of *H. fastigiata*. Thus it seems that the species concepts of Krombholz were not clearly understood from the time the two species were first included in *Gyromitra*. Since my objective here is to elucidate species concepts, the broader argument of generic limits will not be entered, except to say that *Gyromitra* appears to be the best genus for these two species. After they were transferred to *Gyromitra* Fr., later workers have quite consistently given *G. fastigiata* as a synonym of *G. gigas*.

The confusion between these and related species is very complex, as indicated by the following resumé of only a few of the many reports concerning them. Cooke (1879) illustrated the spores of *G. gigas* as broadly fusiform with distinctly pointed ends quite different from those published with Krombholz's original description and quite like those Krombholz described for *G. fastigiata*, but which he did not illustrate. According to Phillips (1893), Cooke's figure was drawn from a specimen in the Berkeley herbarium at Kew. Velenovsky (1920-1922) described and illustrated both species, but he depicted the *G. fastigiata* kind of spores for *G. gigas*, and for *G. fastigiata* he showed spores of the type found in *G. esculenta*. Lohwag (1966) recognized that material which he collected had the fusiform spores of *G. fastigiata*, as he reproduced Krombholz's original description and illustrations of that fungus; but he was apparently persuaded by Maas Geesteranus that it was identical with *G. caroliniana* (Bosc ex Fr.) Fr. [=*Neogyromitra caroliniana* (Bosc ex Fr.) Imai], a species which actually has quite different spores. Boudier (1905) did not report *G. fastigiata;* but he described and illustrated, separately, *G. gigas* and *G. curtipes* Fr. and showed spores of the *G. fastigiata* type for both of them, while stating that *G. curtipes* may be just a young stage of *G. gigas*. Seaver (1928) likewise failed to mention *G. fastigiata* and regarded both *G. gigas* and *G. curtipes* as synonyms of *Helvella caroliniana*. Later (1942) he stated his dissatisfaction with Imai's (1938) separation of *G. gigas* and *G. caroliniana* and recommended that more field work was necessary to resolve the problem. In the latter I strongly concur. His illustrations of spores (Seaver, 1942) are not representative of either *G. gigas* or *G. fastigiata* but appear to be *G. caroliniana* or *G. costata* Schw. ex Cke. In detailing the effects of KOH on species of *Helvella*, Kanouse (1948) did not mention its distorting effect on ascospores (McKnight, 1968). She described the ascospores of *H. gigas* as smooth and indicated as preference for the illustration of Bresadola (1932) over that of Boudier (1905-1910) in interpreting the species. Both authors show strongly apiculate spores, as found in *G. fastigiata*, but Bresadola shows them without surface ornamentation.

Benedix (1969) writes of the typical *gigas apiculus* ("die durchweg typische gigas-anhängsel") with reference to the strongly apiculate-spored species which I call *fastigiata* and treats *H. fastigi-*

ata Krombh. as a synonym of the American species, *Neogyromitra caroliniana* (Bosc ex Fr.) Imai. The latter appears to be a rare species in America, not clearly differentiated at this time from *Gyromitra costata* Schw. ex. Cke. and quite widely confused with a much more common species, *Gyromitra brunnea* Underwood [= *Hellvella underwoodii* (Underw.) Seaver]. Although inadequate details are given, Smith (1963) is the only recent author, to my knowledge, who has correctly distinguished *G. brunnea* and *G. caroliniana.* The spores of these two American species are very much alike and quite different from those of Krombholz's two species being considered here. Nannfeldt (1932) considered *G. fastigiata, G. curtipes* Fr., and *G. labyrinthica* Fr. all as synonyms of *Neogyromitra gigas* (Krombh.) Imai. His description of the ascospores of *N. gigas* is more like Krombholz's *H. fastigiata* than *H. gigas*, and the specimens at BPI and PR *in* the Lundell and Nannfeldt exsiccati confirm this. Fries's original descriptions of *G. curtipes* (1866) and *G. labyrinthica* (1871) give neither illustrations nor written details of the ascospores needed to determine their possible affinity with *G. gigas* and *G. fastigiata.* On the basis of gross morphology Fries (1871) indicated a close similarity of *G. labyrinthica* with *G. esculenta* and *G. caroliniana.* He placed *labyrinthica* and *caroliniana* in a separate subgenus, *Lacunaria.* His illustrations of *G. curtipes* show a fungus very different in color from the other *Gyromitra* species and very much like a variety of *Discina olympiana* Kan. reported recently from Wyoming (McKnight, 1969) and possibly also comparable to Pilat's (1953) pallid variety of *Gyromitra infula.*

The collections reported here fall into two distinct categories as far as spore shape is concerned. These correlate very well with the descriptions given originally by Krombholz for *Helvella gigas* and *H. fastigiata* and permit easy separation of the two species (Figs. 1c, 2c). The fact that the two species have been regarded as one by most observers since their original descriptions by Krombholz tends to obscure the differences which actually exist between them. This is especially true with regard to gross morphology, since many collections have changed on drying so much that the dried specimens give little information about their original form. Having recognized spore differences as a practical criterion for separation of the two species, one can begin to make meaningful observations on other characters such as size, shape, color, and ecology.

These two species appear to have different ecological requirements, as indicated by their distribution in North America (Fig. 3). On the basis of the collections cited here, *Gyromitra gigas* appears to be restricted to the mountains of the West, while *G. fastigiata* appears to be primarily an eastern species, although a few collections of it were taken in Utah, Oregon, Idaho, and Washington. It remains to be seen just how far north and south *G. gigas* extends in the western mountains and how common *G. fastigiata* is in the West and particularly in the Northwest. Snyder (1938) reports *H. caroliniana* from Tacoma, Wash., although his description is not sufficiently detailed to distinguish it from *G. fastigiata.* In an unpublished thesis, Brough

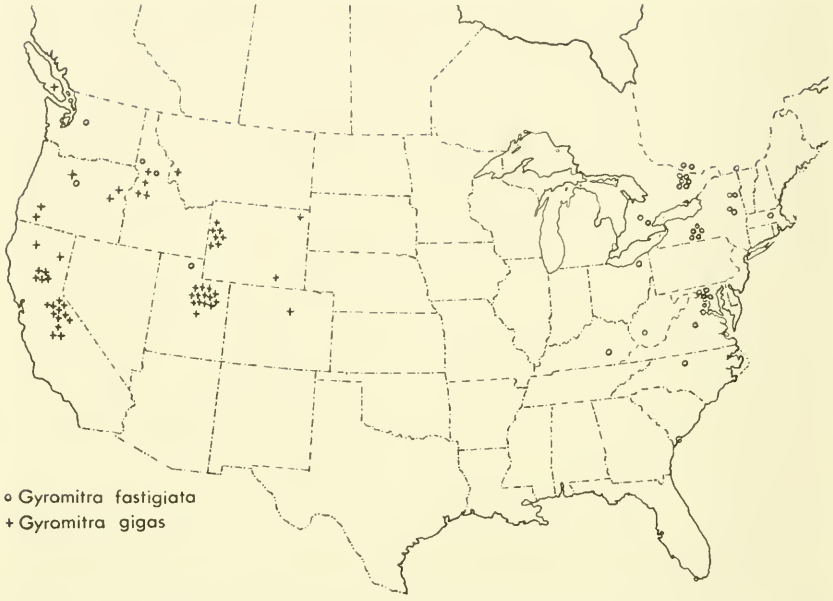

Fig. 3. Distribution of two species of *Gyromitra* in North America based on collections studied for this report.

(1958) refers the Tacoma collection and two other Washington collections to *Neogyromitra gigas* (Krombh.) Imai. His drawings of the spores of one of them, presumably from near Lake Keechelus, show the long apiculus of *G. fastigiata.* The specimens could not be obtained for study. The number of European collections examined in this study is too small to reach any conclusion except the tentative suggestion that *G. fastigiata* appears to be much more common than *G. gigas.*

There may be a significant difference in the conditions which stimulate fruiting for these two species. Krombholz described *H. gigas* as fruiting in March and April and *H. fastigiata* as appearing in April. Nannfeldt (1932) stated that *G. gigas* emerges slower than *G. esculenta*, and Falck (1923) gives the fruiting for *G. esculenta* as March to May and for *G. gigas* as April to May. From their illustrations and descriptions as well as the Lundell and Nannfeldt exsiccati specimen cited above it is clear that Nannfeldt and Falck both were dealing with *G. fastigiata* as the species is used here, not *G. gigas.* This difference in time of fruiting may not be significant in itself, since all three are clearly early spring-fruiting species; but the frequent association of *G. gigas* with melting snowbanks may be important. In those areas where both *G. fastigiata* and *G. gigas* occur observations should be made on this and on details of morphology to see if other differences can be found.

Much has been written about spore ornamentation in the *G. gigas-G. caroliniana* complex. There is some confusion resulting from faulty taxonomy of the species but also some due to differences in sport ornamentation in different populations of *G. gigas* and in maturity of spores of *G. fastigiata*. Although Krombholz illustrated the spores of *H. gigas* as smooth, I admit into the species those with slightly roughened spores having spore characteristics otherwise appropriate for *G. gigas*. Actually there is much variation within the species with regard to this character and to spore size, shape, and apiculus. Since, when present, spore ornamentation seems to develop late in maturation of the spores of all the Discineae, this character must be used with caution in characterizing the species. However, spores of some specimens of *G. gigas* collected on a coverslip from maturing ascocarps have smooth spores while those of other specimens are faintly roughened (Fig. 2). In *G. fastigiata* the reticulum is more distinct and more consistently present on mature spores. In both *G. fastigiata* and *G. gigas*, in contrast to *G. caroliniana* and *G. brunnea*, the reticulum is much finer and lower and is not drawn up into spicules toward the spore apices. These differences were accurately shown by Maas Geesteranus (1965, Figs. 3 and 4) and parallel the differences in ornamentation shown by me (McKnight, 1969) for *Discina macrospora* Bub. and *Discina warnei* (Pk.) Sacc.

Although I have seen few fresh specimens of *G. fastigiata*, my notes on these and on numerous collections of *G. gigas* indicate that there may be a very subtle but significant difference in color of the fresh hymenium of the two species, *G. fastigiata* being more yellow than *G. gigas*. In both species there is considerable color variation on a single specimen and even more between specimens and between collections. However, the various hymnium colors of both are in the large blocks of color designated "strong yellowish brown," "strong brown," and "moderate brown" by Kelly and Judd (1955). Some specimens of *G. fastigiata* were also recorded as "dark grayish yellow," and the "strong yellowish brown" is more yellow than that of *G. gigas*, as indicated by the Munsell notations reported above. Such small color differences really may not be significant at the species level, but they do seem to be confirmed by a subtle difference in hymenium color in the two species as seen in well-dried herbarium specimens. Observations on color range of the two species fruiting in the same area could be important in establishing the significance of this character in species differentiation. Collectors in Washington, Idaho, Oregon, and Utah should watch for such an opportunity.

The significance of gross morphology and ascocarp size in distinguishing these two species cannot be assessed without more field observations, particularly on *G. fastigiata*. While admitting to having seen two few fresh collections of *G. fastigiata* for a final judgment, I get the impression that differences in size and macroscopic form between it and *G. gigas* are not enough to permit distinction of fresh specimens of the two in the field without examining their spores. The "fastigiate" form described originally and illustrated by Krombholz (1832) appears to be uncommon in either species, but this con-

clusion may be premature for *G. fastigiata*. Both species are exceedingly variable in gross form and size. The receptacle is very much convolute in some specimens with numerous small folds extending in all directions, whereas in others it is almost smooth. This character does not necessarily change with age. Although the stipe varies greatly also, it can always be characterized as thick, longitudinally ribbed or lobed, and containing multiple channels inside throughout part or all of its length, contrasting with the typically solid stipe developed on some specimens of *Discina*. The receptacle is usually folded back against the stipe and is often intergrown with it. The entire ascocarp may be wider than it is tall, and the stipe may be almost completely hidden by the recurved receptacle. In all specimens of some populations the stipe may be very long, calling to mind Krombholz's (1832) illustration of *Helvella tremellosa* Krombh. It may be basically cylindrical or expanded downward. The very short stipitate forms of *G. gigas* bear a close resemblance to specimens of *Discina apiculatula* McKn. which have an especially well-developed stipe, and short stipitate forms of *G. fastigiata* look superficially like *D. perlata* or *D. macrospora* Bubák. They are readily recognizable in the field, however, in spite of the fact that they sometimes grow in mixed populations as do different species of *Discina* (McKnight, 1969) and other combinations of *Gyromitra* and *Discina*. Last summer in the Uinta Mountains I found one specimen of *G. gigas* with a specimen of *Discina perlata* (Fr.) Fr. actually touching its stipe. Fruiting in such close proximity suggests that the mycelia grow intermixed in the soil. One small, solitary specimen of *G. fastigiata* collected in Maryland (McKnight 11739, BPI) had an entirely discinoid receptacle and multilacunate stipe. Further observations are needed on species in both genera to circumscribe the species accurately, after which the thorny problem of generic concepts may be resolved.

Acknowledgment

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NEW EVIDENCE FOR THE PRESENCE OF TURKEY IN THE EARLY POSTGLACIAL PERIOD OF THE NORTHERN GREAT BASIN

Stephen F. Bedwell[1]

Archaeological excavations in the Fort Rock Valley area of south central Oregon (part of the farthest northward extension of the northern Great Basin) cast new light on the faunal picture of that area between 11,000 and 7,000 years ago.

In the summers of 1967 and 1968 an archaeological crew from the University of Oregon, under the direction of the author, excavated several caves located on the margins of a large pluvial lake[2] that existed in that area up until some time in the latter part of the eighth millennium.

In one cluster of early habitation sites, known as the Connley Caves, evidence of abundant human occupation was found in the form of tools, bone, and charcoal. The time of this occupation was established, through the use of radiocarbon 14 dating, as having occurred between 11,000 and 7,000 years ago (Bedwell, 1969). This material was also sealed off by a continuous six-inch layer of pumice from the eruption 7,000 years ago of Mount Mazama (the eruption that initiated the formation of present-day Crater Lake).

Bone material found in these caves was part of the refuse left behind by the human inhabitants of the area and serves as an indicator of the diet of these early peoples. Above the Mazama pumice at these sites the faunal material differed little in content from what would be found in this area during the present day. Below this layer, however, particularly in the 10,000- to 8,000-year period, large quantities of turkey bone were found.[3] It is apparent that turkey was abundant in this relatively more moist anathermal period and was one of the staples in the diet of the local inhabitants. Nevertheless, after the Mount Mazama eruption at 7000 B.P. (a point in time that also coincides with the onset of the hot, dry altithermal period[4]) no more turkey remains had been found in any of the caves in the area. To the author's knowledge, this is the first report of turkey having been present in the northern Great Basin at any time. Distribution studies indicate that the nearest ranges, established through current reports, historic accounts, and archaeological investigations, are to be found in Arizona, New Mexico, and Colorado (Bent, 1932; Jewett, 1953; Schorger, 1966).

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[2]Ancient Fort Rock Lake (Allison, 1940, and Bedwell, 1969).

[3]Bone material identified by Robert W. Storer, Curator of Birds; and Joseph G. Struach, Research Assistant, Museum of Zoology, University of Michigan, Ann Arbor, Mich. No species given.

[4]For a description of this period see Anteves (1938).

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CANNIBALISM IN CAPTIVE RATTLESNAKES

Robert E. Bullock[1]

On September 15, 1968, I received five newly "born" prairie rattlesnakes (*Crotalus viridis viridis*) that had been captured near Lewistown, Mont. The rattlers were placed in a relatively large glass terrarium (30 inches by 12 inches) to facilitate behavioral observations. I fed them dismembered field mice (the rattlers were too small to eat mature mice) approximately every eight or nine days. For the first few feedings the rattlers were allowed to kill the mice that were to be dismembered, later the pieces of mice were put directly into the cage. Those snakes that did not adapt to feeding in this manner were killed and preserved; those that were feeding regularly were kept in captivity for five months. Near the end of the fifth month of captivity (February 13, 1969) one of the more aggressive rattlers swallowed one of his cage-mates, of approximately the same size, tail first. The snake that was swallowed was apparently dead, or near death, when the process of engulfing commenced; when the cannibalistic act was noticed, the snake being eaten was swallowed except for its head and neck and was not struggling (Fig. 1).

The swallower was kept under close observation and on February 20, one week later, the swallowed snake was regurgitated. Shortly afterward, another snake in the terrarium swallowed the regurgitated bolus but regurgitated it almost immediately. The original feeding rattler then swallowed the bolus once again and finished the digestive process.

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Fig. 1. A juvenile prairie rattlesnake (*Crotalus viridis*) swallowing a cagemate of approximately the same size, tail first.

Although cannibalism in captive and naturally occurring rattlers has been reported on several occasions, it is rare and usually takes place only under certain conditions. Klauber (1956, Rattlesnakes, Univ. Calif. Press, Vol. 1) states that cannibalism in rattlers usually occurs through the unnatural conditions of captivity: the result of snakes starting to eat the same prey simultaneously and one snake getting its upper jaw over the edge of the cagemate's, or when rattlers are crowded and hungry. He also reports that rattlers have been known to eat dead snakes of their own species.

Regurgitation is not uncommon in captive rattlers that are force-fed, fed a meal too large, or just fed food that does not agree with them (Klauber, 1956). The inference is, however, that this phenomenon usually occurs shortly after or during the swallowing process and not a week later.

As to the manner in which rattlers swallow their prey, it is usually accomplished in a head-first fashion (Klauber, 1956). It is the combination of this rather rare method of engulfing prey with the fact that the rattlers had been feeding fairly regularly and were not overly crowded that makes this particular cannibalistic observation and photograph of interest.

A SURVEY OF NESTING HAWKS, EAGLES, FALCONS AND OWLS IN CURLEW VALLEY, UTAH

Joseph B. Platt[1]

Abstract.—During the summer of 1969 a survey involving 45 nesting nocturnal and diurnal birds of prey was made. Prey items, nest site selections, and productivity for great horned, long-eared, burrowing and short-eared owls, golden eagle, prairie falcon, kestrel, harrier and ferruginous, red-tailed and Swainson's hawks were determined. The turkey vulture, accipiter hawks, barn and screech owls were also recorded.

The total raptor impact on the environment was determined to be slight, whereas the limits placed on the nesting species are considered substantial. It was noted that immature eagles were in the valley and, because they did not require a nest site, were able to utilize areas away from suitable nest sites. Ferruginous hawks had a clumped distribution because the nest sites (junipers) were aggregated on the valley floor. Red-tailed hawks and kestrels required nest sites not typically found in undisturbed desert communities and were found more commonly in agricultural lands. The golden eagle was the only species studied that did not produce a replacement population, i.e., a minimum of two young per pair, although observations outside the valley proved this to be a local phenomenon.

Curlew Valley is a sagebrush basin located on the Utah-Idaho border. It is bounded on the east and west by mountain ranges rising 9,900 ft above sea level. To the north rolling hills close the valley off from the Arbon and Rockford valleys. To the south lie the salt flats of the Great Salt Lake and the lake itself. Elevation of the valley floor begins at 4,200 ft above sea level near the salt flats and steadily rises to the north. The northern edge of the valley floor was determined to be 4,950 ft above sea level.

The climate is arid. The northern region receives 12 to 14 inches of precipitation while the southern part receives less than 8 inches annually. It comes mostly between fall and spring, with only localized storms to break the summer drought. Mean July temperatures are about 20 C, with 38 C commonly reached during July and August. Twenty-four-hour fluctuations of 20 C are also common.

The receding waters of glacial Lake Bonneville and its remnant, the Great Salt Lake, have had a profound effect on the vegetation of Curlew Valley. The salt flats to the south are too harsh for any plant. Pickleweed (*Allenrolfia occidentalis*) is first to pioneer. Moving north and away from the lake, greasewood (*Sarcobatus vermiculatus*), shadscale (*Atriplex confertifolia*), and big sagebrush (*Artemisia tridentata*) appear in distinct communities. Utah juniper (*Juniperus osteosperma*) covers the valley slopes and occurs in scattered stands throughout the valley.

The native funa includes 20-30 species of rodents and lagomorphs. Birds are represented by 20-30 species of passerines and 13 species of raptors. There are 10-15 species of reptiles represented (Desert Biome Research Design, May 1969).

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Land use in the south is limited to grazing cattle and some sheep. Some reseeding with crested wheat grass (*Agropyron cristatus*) has intensified the grazing effort. These reseedings amount to 10% of the valley and are in various stages of reverting to sage.

Near U.S. Highway 30, which nearly bisects the valley into a northern and southern half, dry-land wheat farming becomes a common land use. Fourteen per cent of the valley floor, predominantly in the northern half, is under farming use.

Purpose and Methods

The purpose of this study was to find the relative abundance of nesting raptors, determine their nesting success, and sample their food habits. Studies of individual species have been made in the West (see Murphy et al.) 1969; McGahan, 1968) but little is known about the total role of predacious birds in a desert community and the limiting factors imposed on raptors by the community. The study was limited to the valley floor, that part of the valley below 5,000 ft, thereby eliminating the valley slopes which were densely covered by juniper. The time required to search these slopes could not be justified by the slight returns of nests found. Five hundred and forty square miles were then outlined as the study area on the floor of Curlew Valley. The study was conducted from March through July 1969.

Search methods consisted of driving the meager road system, watching for raptor movements, and visiting rock outcroppings and isolated trees. Observations were begun well before deciduous trees leafed out in mid-April. Two flights were made over the study area in a Piper Super Cub to locate nests. It proved very effective late in the season over juniper stands where *Buteo* activity was suspected. Observation was aided by a Bausch and Lomb 20-30 x 60 mm spotting scope and 8 x 30 mm binoculars. Other students working on separate projects in the same area contributed greatly with their findings. Forty-five nests of raptors were found; they represented 11 of the 13 species present.

Great Horned Owl

Bubo virginianus

The first bird of prey to bring off young in the spring was the Great Horned Owl. The average hatching date for the three nests found was 1 April, with a four-day spread. An average of 2.3 eggs hatched per nest (Range 3-2). One nest failed, reducing the fledging success to 1.7 (3-2) for the three nests. Average fledging date was 8 May.

Two of the owl nests were between agricultural lands and sagebrush hills; the nests were within 300 yards of one another. A bend in the canyon separated the sites. Food remains reflected a similarity in prey taken. In 7 entire pellets from one nest, there were 16 prey items, including 11 *Microtus*, 3 *Peromyscus*, and 2 unidentified

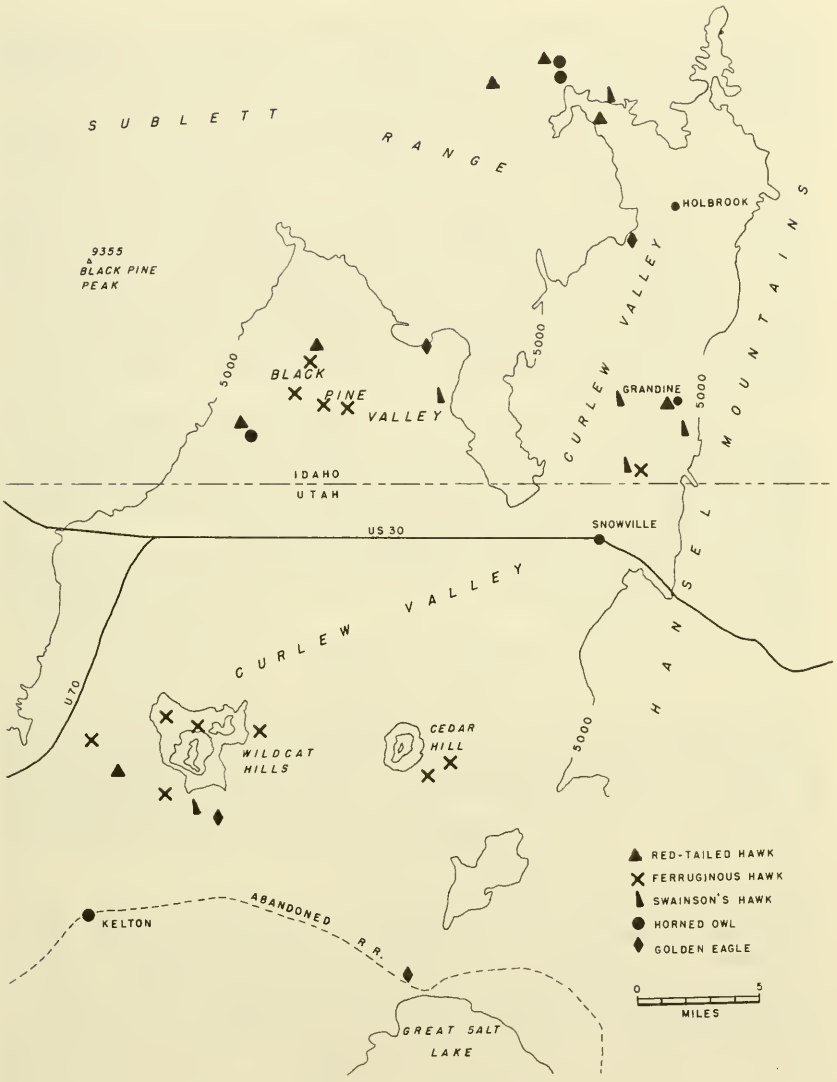

Fig. 1. Nest site grouping for five species of raptors in Curlew Valley, Utah.

rodents. An analysis of broken pellets from the same nest showed the same predominance of *Microtus*. Of 36 individuals, 14 were *Microtus*, 6 *Peromyscus*, 4 *Thomomys*, 2 *Lagurus*, and 1 *Perognathus;* there were also 9 unidentified rodents.

In 5 pellets from the neighboring nest 4 *Microtus*, 3 *Lagurus*, one each of *Peromyscus* and *Thomomys*, and an unidentified rodent were found. A gray partridge (*Perdix perdix*) was also found.

Both pairs of nesting owls seemed to be hunting the sage-grassland areas as well as the dry farmland. *Peromyscus* and *Lagurus* are resident in sagebrush, while *Microtus* and *Thomomys* frequented the disturbed (i.e., farm or pasture) areas. As an indication of a night's success, one nest was twice found to contain two fresh cottontail rabbits (*Sylvilagus sp.*). An early morning visit to the other nest produced 12 rodents: 8 *Microtus*, 3 *Onychomys*, and 1 *Lagurus*.

The third horned owl pair nested in an abandoned farmyard in Blackpine Valley. The country was considerably more open, with heavy cattle grazing on much of the surrounding land. Twenty-five prey items were found in 12 pellets: 13 *Microtus*, 6 *Peromyscus*, 3 entirely of rabbit, 1 *Lagurus*, and 2 unidentified mammals. Seven of the nonrabbit pellets contained rabbit fur. In a single visit, 1 cottontail and 2 young, partially eaten jack rabbits (*Lepus californicus*) were in the nest.

The scarcity of *Lagurus*, which is found in native vegetation, and the predominance of *Microtus* and rabbit are indications of the disturbance to the range. The Blackpine nesting pair's prey items differed markedly from the other two nests, but both were indicative of the prey items available in their respective areas.

Great horned owls were resident throughout the winter in Curlew Valley. In November and every month thereafter, hooting was heard at two nest sites.

Long-eared Owl

Asio otus

Long-eared owls occur in small but undetermined numbers. One nest was found and another reported. The nest examined was in a windbreak of Russian olive between a pasture with sagebrush and a field of wheat. A topless magpie nest was used. Four young, varying greatly in size, and an infertile egg were found. The average date for fledging was 12 May.

Fourteen prey items were found in nine pellets. They were: 5 *Microtus*, 2 *Peromyscus*, 2 *Perognathus*, and 5 unidentifed small mammals. Insects (Coleoptera) were present in one pellet.

The owls seem wholly nocturnal and were never observed away from the nest trees. Magpies nested within 50 yards.

Burrowing Owl

Speotyto cunicularia

Burrowing owls were a very common nesting raptor; in all cases badger dens were used. Early in the nesting cycle one adult of each pair habitually perched on the mound at the burrow's mouth. Upon approach, the perched adult would crouch in the hole or behind the mound with only its eyes and upper portion of its head showing. As the intrusion became certain it would fly 10 or 15 yards and perch on the ground. Sometimes a second adult would then flush from the

interior of the burrow. After flushing, an adult would occasionally pass overhead, calling in protest.

In a two-hour aircraft flight in search of coyote dens, 16 burrowing owls were seen perched at the mouth of badger burrows. This is another indication of the abundance of this raptor.

Production could not be determined prior to the emergence of the young. The three nests investigated in depth produced an average of five young (7-3). The young emerged during the first week in June. They still scurried underground during July for safety rather than flushing. One of the three burrows was accidentally destroyed by chaining the land to clear sagebrush.

The burrowing owls brought dry cow dung into the dens; small flakes of dung covered the mound of the burrows as well as the floor of the entrance (see also Bent, 1938:385). With the increase in traffic when the young emerged, the dung was scattered and mixed with the surrounding dirt.

Burrowing owls are largely diurnal. They could be seen during cooler days perched on fence posts. Few pellets were found around the burrows before the young began emerging. Prey items, however, were found. They were *Peromyscus*, *Microtus*, a toad (*Bufo* sp.), Coleoptera, a skink lizard (*Eumeces multivirgatus*), a scorpion (Scorpionida), an immature horned lark (*Eremophila alpestris*), and unidentifiable insects.

When the young began coming above ground to perch around the mound, pellets became numerous. Eighteen complete pellets were examined; three were entirely of insect remains, 8 *Peromyscus*, 6 *Microtus*, 2 *Lagurus*, 1 unidentified rodent, and an insectivorous bird (probably horned lark) were found. All but two pellets had some insect remains. Of all the raptors studied, these owls made the greatest use of insects.

Barn Owl

Tyto alba

In late June a female road-killed barn owl was found on the western edge of Snowville, Utah. It had a brood patch that suggested it was nesting in the area.

In late July three immature barn owls were flushed from along the high dirt banks of Deep Creek, 4 miles from where the female was recovered. The most likely nest sites were cavities in this creek bank.

Whether the road-killed barn owl was part of this family group or not, there apparently were more than two adults in the area.

Screech Owl

Otus asio

The screech owl was an uncommon nester. One nest containing four young was found during May. However, half of the young were removed thereby invalidating production data.

The nest was in a hollow of a juniper tree. It was located off the valley floor on the slopes west of Kelton.

Short-eared Owl

Asio flammeus

Short-eared owls were seen commonly during cooler days perched on fence posts. About dusk, as the harrier (*Circus cyaneus*) activity dropped off, short-ears began flying low over sagebrush and agricultural fields. Like harriers, they hunted from low perches or by coursing over vegetation. They are similar in size and ability to subdue prey; it seemed that harriers and short-eared owls were exerting constant diel pressure upon those species vulnerable to their methods of hunting (see also Sparks and Soper, 1970:137).

Nests were in sagebrush as well as in the grass pastures. Young were fledged at two different times during the summer. The main fledging was throughout May. During the first week of July, however, three family groups were found made up of young barely mature enough to fly. Raptors have a relatively long period of dependence after fledging. The late nestings mentioned are not interpreted as an indication of owls raising two clutches in a single season. It does indicate, however, that the owls are capable of renesting.

Thirteen prey items were identified at one nest from pellets. Eight were *Peromyscus*, 3 *Microtus*, 1 *Lagurus*, and 1 unidentified rodent.

Perhaps a dozen short-ears were found dead on the roads of Curlew Valley. Only two burrowing owls were found dead and one Swainson's hawk (*Buteo swainsoni*). The kills were not in connection with carrion and were predominantly immature short-ears (deaths were probably due to chasing quarry in front of cars).

It is not known if short-ears winter in Curlew Valley; they are found in northern Utah all winter. On 12 February ten birds were seen in Curlew during the day—all in a group, flying, sitting, and chasing one another.

Golden Eagle

Aquila chrysaetos

Four golden eagle nests were found in the valley; three of the four failed. One of these nests was abandoned when rocks from an overhang fell onto it. The rocks were larger than the eggs and prevented incubation. The adults, however, remained in the area. The second nest contained three eggs (typical clutches have two). It is not known why this pair failed. A single adult bird was still seen near the nest during August.

The third nest to fail was not found until after young should have fledged (30 June). Two adults frequented a group of cliffs. No young were ever seen with them. A nest was found with molted eagle feathers in and around it. It was well lined with straw, and sprigs of green juniper were present. The cup was well defined.

The nest had no food remains and the amount of excrement suggested there had never been young in the nest. The nest was easily accessible to any mammalian predator, and predation may have caused its failure. Another possibility is that the pair were too young to breed but had established a pair bond (as suggested by Brown and Amadon, 1968:668).

The one successful nest fledged two young. Like the other three it was a cliff nest. Young hatched during the last week of April. Fledging was on 7 and 10 June, the smaller eaglet leaving first. Thirty-one prey items were removed from the eyrie; they consisted of an adult short-eared owl and 30 rabbits. At least 80% of the rabbits were adult jack rabbits; the other 20% were either young jack rabbits or cottontail rabbits. An eagle nest provided the only obvious example of carrion feeding for this study. A nest which failed had the foreleg of a deer in it.

Four nonbreeding immatures were regularly seen. These eagles were paired into two groups. In both groups the two birds perched and were generally together. All bore the basal white tail of birds less than four years and therefore were too young to breed (Brown and Amadon, 1968:668). Two additional immatures were recorded separately, but were not confined to any area.

Golden eagles were not found in Curlew Valley during the late winter. In November, a subadult (i.e., less than four years old) was flushed from a rabbit. The next sighting, again of an immature, was in March.

Prairie Falcon

Falco mexicanus

Two pairs of prairie falcons nested in Curlew Valley; both were successful although the nests were less than 4 miles apart. Each pair had 5 fertile eggs. One of the 10 eggs failed to hatch, giving an average hatching of 4.5. The average fledging success was also 4.5. Mean hatching date was 8 May; fledging dates averaged 13 June.

Three pellets were found at the northernmost nest in the week hatching occurred. One pellet contained rabbit, one an antelope ground squirrel (*Citellus leucurus*), and the third a horned lark. On the day the southern nest hatched, five pellets were gathered. Three of these were the remains of mammals and two, the remains of an avocet (*Recuricirostra americana*). These pellets were from the adult birds, as the young are not fed roughage until they are older than these birds were at the time the above collections were made. Both nests reflect an adult diet with mammals forming 60%. Twelve days after hatching, one nest contained six pellets and the remains of five avocets. Five of the pellets contained fur, but all had feathers in them. After another six days, the remains of four avocets and two passerines were found in the same nest. The only mammalian evidence was a single cottontail rabbit leg. Apparently the adults were feeding on the abundant mammal population until the young

hatched. Then, presumably for the young's dietary need or because of the supply of immature birds available, the prey selection switched to birds. Of note also was the heavy utilization of avocets by one pair. In 18 days 11 avocets were brought to the nest. The nearest avocet habitat was over 4 miles away. Entire birds were sometimes brought in. A single horned lizard (*Phynosoma* sp.) was brought to the nest but was not consumed.

Prairie falcons wintered in the northern part of Curlew Valley. Immatures were found until December. At that time adults established territories and would not tolerate the younger birds. Adults were seen chasing immatures as early as October.

Kestrel

Falco sparverius

Male kestrels were found in Curlew Valley throughout the winter. In 5 surveys made during the winter, 18 kestrels were sexed (19 were seen), 17 were males (see Willoughby and Cade, 1964, for similar findings of sex ratio imbalance). The single female is discussed below.

The kestrels nested in April and young fledged the third week of June. In a sample of three pairs the average number fledged was 4.0 (5-3). Female nestlings outnumbered males two to one. Deserted buildings were commonly utilized. Cavities were seldom found in the native juniper trees but were used when the holes were available.

Kestrels tolerate one another quite well. At two nests a second pair were in residence within 200 yards. Lone males were seen near other nests. Nonbreeding males were observed throughout the valley. They often occupied perches along roads, miles from suitable nesting sites. One male could be found in a group of trees 50 yards from one of the Grandine nests. It would vigorously protest human intrusion, but no female was ever seen in dozens of sightings.

Food habits were unknown except for a few kills witnessed on roadsides. One was a *Microtus;* the others were unidentified small mammals.

The single female known to have wintered in Curlew Valley was a partial albino. She was first sighted in early fall 1968 and was banded in December. He eyes were a smoky gray; two light stripes of gray could be seen on her head. The upper secondary coverts were also pale gray, giving the appearance of two bands across her back. The tail had a faint red cast caused by light red pigment in the same position as the red bands on a normal female kestrel. The alternating black tail bands were completely lacking. He feet and cere were bright yellow. Three of the central tail feathers were heavily worn and broken. The tail banding and size of the feet were used to determine the sex.

No further sightings of the albino were made until 23 March, when she was found less than a mile south of where she was banded

the December before. She was again seen in May, 2 miles north of the banding point, then the next day, one-half mile south of it. On these last sightings it could be seen that the damaged tail feathers had been replaced by the molt. The reddish cast to the tail was still evident, but the presence of wing coloration could not be determined.

This albino evidently did not breed. Nesting females could be found in close proximity to their nesting site. Even after the fledging of the young, family groups remained within three-quarters of a mile of their nest until mid-July. The albino's movement of 3.5 miles in 24 hours and her solitary condition did not fit the pattern of a breeder.

Harrier

Circus cyaneus

Like the short-eared owl, harriers were common nesters but difficult to locate. During every month of the winter, harriers were in Curlew Valley. On 12 February, five were seen diving at and chasing one another; this was the same day that similar behavior was observed in a group of short-eared owls.

A single nest was found. It had five eggs, three of which hatched. On 15 June, one young could fly and the other two hopped and ran through the surrounding cover. No prey remains were found because of the mobility of the young and because the parents removed leftover kills. Adults were, however, flushed twice from immature horned larks.

Fewer than a dozen adult (gray) males were heavily outnumbered in the valley by dark birds. Some of the dark birds were certainly subadult males and may have been breeding (see Hamerstrom, 1969:376).

Ferruginus Hawk

Buteo regalis

Of all the tree-nesting raptors, ferruginous hawks most fully utilized the nonagricultural lands of Curlew Valley. Twelve pairs were found nesting. Eleven nests were successful, and one failed before the hatch. Forty-one young fledged, yielding a production of 3.4 per nest (5-1). Hatching day averaged 15 May with the mean fledging date of 5 July. All 12 pairs utilized existing nests. Eleven of these were in junipers and were not significantly altered. These 11 appeared to be old ferruginous hawk nests. The 12th nest was in a windbreak of eight narrow-leaved cottonwood trees between two plowed fields. Although an old nest was used, it appeared to be that of a Swainson's hawk (*Buteo swainsoni*). Indeed, a Swainson's hawk was flushed from this group of trees in late March. On 6 April, two ferruginous hawks were seen carrying sticks to the nest. Both birds participated. The material was gathered from beneath the windbreak in which the nest site was located. Both birds seemed to arrange sticks, but one made more gathering forays. The nest was

nearly doubled over its original size. A pair of Swainson's hawks was found nesting 400 yards from these ferruginous hawks.

Mortality was recorded at four nests. One nest was found late; it had a single three-week-old chick in it. The loss of eggs or nest mates is assumed. At the other three nests, some of the young died within three weeks of fledging. One became entangled in the nest tree when it left the nest in a storm and was strangled to death. Two out of five young died in a nest where the adult male was found dead three weeks earlier. There was no indication that he was replaced; from the first week of June until 2 July a lone parent kept five young alive, and by 9 July three of them fledged.

A fledged young in a fourth nest died while attempting to regurgitate a rabbit foot. No other food was in the crop, and the foot was not digested. This indicated that it had been swallowed not long before death.

Food habits of this species showed the greatest variety of any hawk recorded; 12 species of prey items were found. Eighteen pellets were examined; 10 of them were of rabbit fur, 2 contained weasel (*Mustela* sp.), 1 of *Thomomys*, 1 of *Dipodomys*, and 1 of short-eared owl. Three contained unidentified mammal. An indication of the variety of prey taken was noted form nest remains. Pheasant (*Phasianus colchicus*), meadowlark (*Sturnella neglecta*), leopard lizard (*Crotaphytus wislizeni*), and an adult male harrier were found along with the usual *Microtus*, *Citellus*, and both Lagomorphs.

Rabbits were an important part of the food brought to some nests but utilization varied. Using rabbit hind legs as an index to prey selection, the following variation was observed: three nests on a four-mile line in the Wildcat Hills showed 12 rabbits in 20 days, 7 rabbits in 30 days and 8 in 25 days. Two nests in Blackpine Valley had 6 rabbits in 30 days and 2 in 19 days. The frequency of rabbits, then, varied from 0.6 to 0.1 rabbits per day. The reasons for this inconsistent use of rabbits are unknown. Jack rabbits seemed abundant and cottontails could be found near rocks or heavy cover. It may reflect local rabbit fluctuations, or it may represent a selection being made by individual hawks. For the recorded nesting population, rabbits made up one-third to one-half of the diet.

In two instances adult ferruginous hawks were seen carrying large jack rabbits. Occasionally entire adult jack rabbits were found at the nest. All parts of rabbit skeletons were found often enough at the nest that it can be assumed ferruginous hawks are capable of regularly killing and carrying adult jack rabbits.

An interesting behavioral note was the presence of dry cow dung in the 11 juniper nests. Chunks of the dung were found in the top portion of the nest structure (see also Weston in Murphy, 1969:29). Cattle shaded under the nest tree and others nearby.

Ferruginous hawks have considerable tolerance for red-tailed hawks and for one another. In Blackpine Valley, which is a large, level expanse of sagebush and grass, four pairs nested. Two pairs of red-tails also nested there. Three ferruginous nests could be fitted on

a line 2.3 miles long. Less than a mile north of the line was a successful pair of red-tails. If lines were drawn from the red-tail nest to the end nests on the line, a triangle measuring 1.3 by 2.3 by 2.4 miles would be formed. On its perimeter were nests of three ferruginous hawks and a red-tailed hawk. Within its boundaries was a fourth ferruginous nest. These five nests represented 10 adults and 19 fledged young. A second successful red-tailed hawk nest was 1.7 miles west of the western corner of the triangle. All nests were in sight of one another.

Red-tailed Hawk

Buteo jamaicensis

Seven nests of red-tailed hawks were located in Curlew Valley; five fledged young. Eight young are known to have fledged from four nests with one nest unaccounted for. Production was 2.0 young per nest. Average laying date was 12 April and average hatching date 15 May. The young fledged during the second week of July. Four young were found dead before fledging. Two were blown out of the tree, along with half of the nest material, at three weeks of age. The third disappeared at 20 days. The fourth chick found dead was a lone chick in a nest with a parent bird having subadult plumage.

Nesting red-tailed hawks generally preferred trees taller than junipers. Four were in cottonwoods, one in an aspen, and two in very tall junipers. This affinity for tall trees caused red-tails to nest in agricultural land 57% of the time. Agricultural land, it should be recalled, made up only 14% of the valley. The red-tail diet reflects this association also; out of 18 prey items found in pellets, 8 were *Microtus* and 7 were *Thomomys*. The others were a lizard and 2 rabbits. When these pellets were gathered adult red-tails were seen on fence posts in agricultural lands; later in the nesting season rabbits became common nest remains. The hawks may have had to shift their emphasis to rabbits due to the maturing crops that provided increased cover for small rodents.

Four red-tailed hawks in immature plumage were resident in Curlew; one nested with an adult mate. The nesting site was in a half-dead Lombardy popular on a creek bank. A dilapidated hawk's nest was present from years past. On 5 April the pair exhibited nest defense. Copulation was observed on 3 May (22 days after neighboring red-tails had begun laying). The immature plumaged bird took the inferior position, indicating that it was the female.

Eggs of an unknown number were in the nest on 24 May. By 7 June, young were being fed. The nest was climbed for the first time on 15 June; one chick and one egg were found. The chick hatched on or about 6 June, two weeks later than average. Green leaves, which are usually brought into nests periodically by red-tails, were not present. The entire structure looked little improved from its deteriorated state of the previous season. The young did not survive to the age of two weeks. No indication of the chick's fate was apparent, nor could the adults subsequently be found.

The pair was late in becoming established and were not vigorous nest defenders. Nest building or improving, along with the frequent "greening up" of a nest with leaves, may be for the purpose of strengthening the pair bond. These things were not done, which may indicate that this nest was a marginal attempt, and not likely to succeed. A second pair of red-tailed hawks with a member in immature plumage was found off the study area. Their eggs did not hatch.

The other three birds in immature plumage were seen separately throughout the valley in the same areas but with no regularity.

Swainson's Hawk

Buteo swainsoni

Six nesting pairs of Swainson's hawks were recorded. Of all the raptor species studied, they were the latest to nest. On 2 May, a partial clutch was found. Hatching dates occurred in the first week of June. The six-nest fledging average was 2.0 per nest (4-1). A seventh pair defended a dozen junipers containing a number of old nests, but no active nest was found. Elsewhere, a single nest is known to have failed. On 8 June, the only egg in it was heavily pitted; two weeks later the nest was empty.

Swainson's hawks exhibited the only communal hunting seen in the valley. On 9 June, 4 Swainson's were following a plowing operation east of Cedar Hills. On 15 June, 12 Swainson's were circling or perched near a hay mowing operation west of Snowville, Utah. In both cases successful attempts to secure prey were witnessed.

Jack rabbits were found in two nests. *Thomomys* were also found. Brewer's blackbird (*Euphagus cyanocephalus*) and a lark sparrow (*Chandestes grammacus*) were recorded. In one visit, remains of three young jack rabbits and a meadow lark were in a nest.

Turkey Vulture

Cathartes aura

Vultures were first seen in April; thereafter, they were regularly seen in the Grandine area. They are cliff nesters, and east of Grandine a few outcroppings occur that might provide appropriate nest sites.

Late in June at Grandine, a single vulture was flushed from a dead rabbit on the road. Twenty minutes later, half the rabbit and the vulture were gone. No sightings of more than one or two vultures were made until 4 August, when seven were seen soaring north of Grandine. On 9 August, five were again seen north of Grandine.

Accipters

During the month of April all three Accipters (Cooper's hawk, sharp-shinned hawk, and goshawk) were seen in various parts of the

valley. No observations were recorded during May or June. The birds seen early in the summer were probably passing through to their nesting habitat in the nearby mountains where they are known to nest. On 12 July, a Cooper's hawk was seen at Grandine. It was being mobbed by resident kestrels. The hawk was probably representative of the dispersal of young and adults from nesting sites. The valley might possibly be utilized by the birds for postnesting activity.

Interspecific Behavior

At Grandine a kestrel nest was located 30 yards from a red-tailed hawk's nest. When investigators were in the immediate vicinity of the nests, the red-tails usually took prominent perches in nearby trees. When the kestrel's nest was being climbed, the kestrels would circle and "kack" at the intrusion. Without fail, they would begin diving at the perched red-tails, manifesting redirection behavior (see also Moynihan, 1955).

This same redirected behavior was noted once with prairie falcons and golden eagles. The two species nested about 2 miles apart. The falcons were vigorous nest defenders, diving and circling continually when disturbed. The eagles, on the other hand, quietly slipped away when flushed. After drawing a strong response from the falcons, the eagle eyrie was then visited. As the adult left the nest and was gaining altitude, a prairie falcon began diving at the eagle. The eagle showed little response, but climbed higher, drawing its antagonist with it. The falcon finally broke off the attack and drifted toward its own nest.

Kestrels mobbed a Cooper's hawk at Grandine late in the summer; it is believed that the accipiter was not resident but merely moving through. Since hawks with bordering or overlapping territories usually did not bother one another, the prairie falcon mentioned above only reacted under extraordinary conditions.

While two ferruginous hawks were protesting a visit to their nest by the investigator, two Swainson's hawks appeared and began circling and screaming also. The Swainson's were those described earlier as defending a stand of junipers with no active nest.

Conclusions

Forty-five nests were found; nine of these failed. Of the nine, five failed before hatching. Since nest locating was easier after the adults began carrying food to nests, it is probable that some failing nests were not located. Twenty per cent failure (9 of 45) should then be considered a minimum.

No raptor was found to have an obvious limiting effect upon its prey species. The examples of narrow prey selection were eagles on rabbits and the prairie falcon's predation on avocets; both prey items were abundant. All other nests exhibited diversity in prey selection which followed the suspected relative abundance of prey items.

The habitat evidently had pronounced effects on nesting raptors. An overview of the map plotting nest locations shows a clumping of nesting birds. Cliffs or outcroppings suitable for raptors were not common. Every cliff in the valley which seemed suitable to the observer had either an eagle or prairie falcon nesting on it. Nonnesting, subadult golden eagles were present in the valley. Due to the scarcity of nesting sites, they did not have to compete with nesting adults.

Ferruginous hawks frequently nest on the ground (Weston, *in* Murphy *et al.*, 1969; Williams and Matteson, 1948). There they build a large stick nest comparable to the structure they place in trees. These hawks have two avenues open to them in their utilization of Curlew Valley: by nesting both on the ground and in the trees, they could evenly distribute themselves throughout the uniform sagebrush and shadscale habitat. This would reduce intraspecific competition and make for more effective use of the prey populations. Or the hawks could restrict themselves to tree nesting sites. Since the juniper trees are clustered, the hawks would also have clustered distribution. Prey populations farther from trees would thereby conceivably receive less attention from nesting birds. Tree nesting would also intensify interspecific competition for both nesting sites and food resources among ferruginous, red-tailed, and Swainson's hawks.

The apparent advantages of dispersion through ground nesting are outweighed by the security of tree nesting, as no ground nests were found nor was any evidence found that they had ever been employed. Besides the 11 active ferruginous juniper nests, between 20 and 30 inactive or alternate tree nests were located throughout the valley.

Red-taied hawks generally limited themselves to trees other than juniper. The two juniper trees used for nest sites were taller than usual, as was mentioned earlier. One of the pairs used a nest that had been built in an earlier season. It seemed too shallow for ferruginous hawks and may have been built originally by red-tails. The second nest, however, was built that spring and was a mere jumble of sticks by the time the young fledged. One of the two young disappeared during their fourth week. More young may have been lost earlier, as they were 20 days old when found.

Krestrel nesting sites were commonly associated with human alterations. Buildings and exotic trees around farms provided the bulk of nesting habitat for these falcons.

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BODY COMPOSITION AND ORGAN WEIGHTS OF THE VERDIN (*AURIPARUS FLAVICEPS*)

George T. Austin[1]

Studies of ecosystem energetics require a knowledge of inorganic and organic composition of the organisms present. At this time, too few data are available to generalize on the proportion of organic material in birds (but see Turcek, 1960). Lipid composition has been examined extensively, especially in connection with migration studies, but is generally unknown for birds on their breeding grounds (King et al., 1965; Zimmerman, 1965; Yarbrough, 1970). Water content is also known for several species, but few studies have dealt with protein, carbohydrate, or ash fractions (Turcek, 1960; Zimmerman, 1965).

Also of interest are organ weights. Heart and kidney weights have been examined in numerous species, but few weights are available for liver and lungs (Quiring and Bade, 1943; Oakeson, 1953; Quiring, 1962; Dunson, 1965).

While conducting research on the Verdin (*Auriparus flaviceps*), I had the opportunity to examine these factors in a number of birds collected by myself and others in Clark County, Nevada, where the species is a common permanent resident in areas dominated by woody legumes (*Prosopis juliflora*, *P. pubescens*, *Acacia greggii*).

Methods.—Spring birds were collected between 1 March and 5 April 1969 and summer birds on 10-11 August 1969. On collection, the birds were sealed individually in plastic bags and kept on ice until return from the field. Weight (to 0.01 g) was taken within five hours of collection. Spring birds were frozen two to four days, reweighed (weight loss less than one per cent), and the heart, liver, lungs, kidneys, and gonads were excised, trimmed, and blotted of excess tissues and moisture, and weighed to 0.1 mg. Weights of shot damaged organs were discarded.

After weighing, excised organs and trimmed tissues were replaced with the carcass. Stomach contents were removed and their weight subtracted from the original body weight. Carcasses were then subjected to one of two treatments: (1) dried to a constant weight in a vacuum oven (80 C) or (2) completely homogenized in a blender and divided into two or three aliquots which were weighed and dried to a constant weight. Weight change represents body water composition. Differences between the two treatments were insignificant ($P>0.9$ by t test). Those subjected to the latter treatment were analyzed for protein, lipid, and ash content. One aliquot was subjected to ethyl ether lipid extraction in a Soxhlet apparatus, one was analyzed for organic nitrogen by the Kjeldahl method, and one was burned in a furnace (500 C) to determine ash content. The

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difference between dry weight and the weights of protein, lipid, and ash was taken to be carbohydrate weight.

Summer birds were opened, sexed; stomach contents were removed and weighed; and the carcass was dried to a constant weight.

Results and Discussion.—Body composition and organ weight data are presented in Tables 1 and 2, respectively. Body composition data are within the ranges given by Zimmerman (1965) for nonmigrating Dickcissels (*Spiza americana*). Water composition is within the range given for several species (Turcek, 1960; Odum et al., 1964; Helms et al., 1967; Yarbrough, 1970). Lipid levels are also similar to those for birds on their breeding grounds (Zimmerman, 1965; Yarbrough, 1970). Ash content (12.8% of dry weight) approximates the 12% given by Turcek (1960). Total organic biomass was 30% of wet body weight and is within the range given by Turcek (1960). No sexual or seasonal differences were noted.

Body and organ weights were similar among the sexes. The greater weight of females was due to two birds with oviductal eggs (body weight = 8.7 g, 8.1 g). It is of interest that the livers of these two females were larger than any of the thirteen other livers (0.3157 g, 0.2927 g). Organ weights are comparable (as per cent body weight) to those given for small birds (Quiring and Bade, 1943; Hartman, 1955; Norris and Williamson, 1955; Quiring, 1962; Dunson, 1965; Johnson, 1968). Fresh kidney weights were less (by 27% than those given previously for a preserved sample of four Verdins (Johnson, 1968).

Table 1. Body composition of the Verdin.

Component	Spring Per Cent Wet Weight	Per Cent Dry Weight	N	Summer Per Cent Wet Weight	N
Water	66.9	—	16	68.0	13
Solids	33.1	—	16	32.0	13
Protein	24.5	72.3	11	—	—
Lipid	3.7	10.9	7	—	—
Ash	4.4	12.8	5	—	—
Carbohydrate	1.3	4.0	5	—	—

Table 2. Organ weights of the Verdin.

Organ	♂♂ Mean Weight	S.D.	% Body Weight	N	♀♀ Mean Weight	S.D.	% Body Weight	N
Kidney	0.0786	0.0224	1.19	10	0.0772	0.0292	1.05	5
Heart	0.1068	0.0088	1.64	11	0.0959	0.0094	1.31	5
Lungs	0.0895	0.0087	1.37	11	0.0832	0.0127	1.13	5
Liver	0.2106	0.0394	3.24	11	0.2707	0.0423	3.61	4
Left Testis	0.0238	0.0074	0.36	10	—	—	—	–
Right Testis	0.0155	0.0072	0.24	9	—	—	—	–
Ovary	—	—	—	–	0.0291	0.0236	0.39	4
Body Weight	6.51	0.32	—	11	7.34	0.99	—	5

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NEW SPECIES OF BARK BEETLES (SCOLYTIDAE: COLEOPTERA) FROM WESTERN NORTH AMERICA

Stephen L. Wood[1]

On the following pages, seven species of bark beetles (Scolytidae) from the western United States are described as new to science, and notes relating to the identity of *Pseudohylesinus sericeus* (Mannerheim, 1843) are presented. One of the new species, *Hylurgops reticulatus*, is a very common, widely distributed species that has been overlooked; it evidently has significant economic importance. The others, from Arizona and New Mexico, belong to the genera *Pseudothysanoes* (2), *Thysanoes* (1), *Conophthorus* (1), and *Pityophthorus* (2). The holotypes and allotypes are in my collection; paratypes were distributed as indicated below.

Pseudohylesinus sericeus (Mannerheim)

This species was named as *Hylurgus sericeus* Mannerheim (1843, Bull. Soc. Imp. Nat. Moscou 16, No. 2:124) from one or more specimens taken at Sitka, Alaska, by Eschscholtz and Blaschke. When I (Wood, 1969, Gt. Basin Nat. 29:116) treated it, the only specimen fitting these data presently in the Mannerheim collection at the Universitetets Zoologiska Museum, Helsinki, was cited and I stated that it "is considered to be the type." As indicated by Mannerheim's own identification label and by a subsequent additional type label, this specimen has been regarded as the type since 1843. Until it was pointed out by Bright (1970, Canadian Ent. 102:499), I had not considered it significant that Mannerheim's species might have been based on two or more specimens as indicated by measurements given for the species as "Longit. 1⅓, 1½ lin. Latit. ½, 3/5 lin." and by the inclusion of two collectors when only one name was associated with each specimen label in the Mannerheim material. My reasons for this lack of concern were that the specimen probably was intermediate in size between the published figures and that Eschscholtz had been responsible for assembling and getting the collections to Mannerheim, and therefore might have been included as a collector.

On the basis of the above-quoted measurements, Bright assumed Mannerheim's specimen was a syntype and further assumed that the LeConte specimen under this name in the Museum of Comparative Zoology was also a syntype. The Mannerheim specimen in 1968 had a label associated with it, "Hylurgus sericeus sp. n. Mannerheim," that evidently was not sent to Bright. That specimen is 3.3 mm (= 1½ lin.) long. The LeConte specimen is slightly damaged, but evidently is about 2.9 mm (= 1⅓ lin.) in length; it bears a

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gray paper disk (LeConte's locality label signifying Russian America), a square paper label with the number "12," a label "Type 5450" (obviously added subsequent to the time of LeConte), a label "Hylesinus sericeus Mann., Sitka" (on paper and in hand printing similar to other labels in the LeConte collection and very different from that seen in the Mannerheim collection), and Bright's lectotype label. There is nothing on the LeConte specimen to indicate it was part of Mannerheim's series or that it was taken by Eschscholtz or Blaschke; all labels were added after it came into LeConte's hands. The use of the generic name *Hylesinus* suggests the identification label was written after 1868 when LeConte transferred this species from *Hylurgus*.

Bright did not call attention to the description of *Hylurgus sericeus* var. b. *minor* Mannerheim (1852, Bull. Soc. Imp. Nat. Moscou 1852, No. 2:74, special printing), taken at Sitka, from "truncis pini sub cortice" by Frankenhaeuser. Measurements or other characters were not given that distinguish it from the 1843 description except that it was darker, less scaly and, as deduced from the name, presumably smaller than the type. There is no specimen representing this variety in the Mannerheim collection. The LeConte specimen is slightly darker, less scaly, smaller than the Mannerheim specimen, and is of a species occurring in pine (*Pinus contorta*) bark. The latter point, however, has no significance since several species listed in the 1852 article as from pine bark are now known to occur only in spruce (*Picea* spp.).

In summary, two types have been designated for *Hylurgus sericeus* Mannerheim (1843). One (=*Pseudohylesinus grandis* Swaine, 1917) bears (or bore on the original pin) Mannerheim's own identification label (pinned in the drawer beside the specimen-bearing pin in 1968); it is and always has been part of the Mannerheim collection, and it was taken by Blaschke; for a locality label it bears "in nauve inter California et Brasiliam," not Sitka, but other Sitka specimens taken by Blaschke bear the same label. I (1969) regarded this specimen as the type since it is the only known authentic, original specimen. The other type or lectotype (=*Pseudohylesinus pini* Wood, 1969), designated by Bright, is a specimen in the LeConte collection bearing no original labels; it was presumed to have been received from Mannerheim who subsequently described a variety that was collected at a later date more accurately fitting this specimen. There are many specimens of other species in the Mannerheim material, at Helsinki, from Russian America, that were not mentioned in Mannerheim's publications. Some of these were sent to LeConte. It is entirely possible the LeConte specimen of *Hylesinus* (not *Hylurgus*) *sericeus* was one of these. Bright did not present any evidence, nor have I been able to find any, proving that the LeConte specimen actually was a syntype. Since a lectotype must be selected from syntypes, Bright's lectotype has no status as such. The evidence that more than one original specimen of Mannerheim's species exists is entirely circumstantial. For this reason I recognize the Helsinki specimen as the holotype of *Hylurgus sericeus* Mannerheim

and consider the LeConte specimen to be an incorrectly identified specimen now referred to *Pseudohylesinus pini*.

Neither of the species in question is of sufficient economic importance to warrant an appeal to the International Commission on Zoological Nomenclature to conserve an established name.

Hylurgops reticulatus, n. sp.

This species is closely related to *porosus* LeConte, but it may be distinguished by the larger average size, by the minutely reticulate elytra, and by numerous other minute characters several of which are mentioned below.

Male.—Length 5.0 mm (paratypes 3.7-5.0 mm), 2.8 times as long as wide; color black, with whitish vestiture.

Frons as in *porosus* except lower half less deeply, less closely, less finely punctured; median carina almost obsolete, visible only in impression immediately above epistoma.

Pronotum as in *porosus* except usually widest near middle, converging anteriorly more abruptly; surface often partly or entirely reticulate, punctures about as on some *porosus* but finer than on most specimens; largest punctures about twice as large as smallest, spaced by distances equal to or smaller than diameter of smallest punctures.

Elytra as in *porosus* except basal crenulations more poorly developed, submarginal crenulations absent; entire surface minutely reticulate (visible at 80 diameters magnification, not visible at 40 diameters); interstrial punctures smaller, more numerous; interstriae very slightly wider, surface less irregular; interstrial crenulations near declivity narrower, very slightly higher; declivital scales more abundant, extending to or slightly anterior to base of declivity; setae in interstrial rows very slightly longer, distinctly coarser.

Last visible abdominal sternum never grooved or pubescent as in males of most other *Hylurgops* species.

Female.—Similar to male except anterior tibiae with five (male with six) socketed teeth; terminal, concealed terga of abdomen only reliable indicator of sex, as in many other species of this subfamily.

Type Locality.—Summit Lake, Shasta Co., Calif.

Type Material.—The male holotype, female allotype, and 13 paratypes were collected at the type locality (Section 8, Township 32 N, Range 5 E), on 28 August 1946, from *Pinus ponderosa*, by S. L. Wood. Other paratypes were taken as follows: one from 8 miles S Ashland, Ore., 15-VI-68, in flight, W. C. Harwood; 55 from Idaho City, Idaho, 21, 22, 23, 24, 26-V, 2-V-70, in traps, M. M. Furniss; one from Cypress Camp, Shasta Co., Calif., 28-VIII-46, *Pinus jeffreyi*, S. L. Wood; one from Burney, Shasta Co., Calif., 11-VI-61, *P. ponderosa*, S. L. Wood; one from Miami R.S., Mariposa Co., Calif., 20-V-42, A. J. Walz; 62 from Carmel, Monterey Co., Calif., various dates from 1908 to 1936, E. C. Van Dyke and L. S. Slevin; 2 from 5 miles SW Jerome, Ariz., 8-VI-69, 7200 ft elevation, *P. ponderosa*, W. G. Harwood; one from Cloudcroft, N. Mex., 12-VI-02, W.

Knaus; and 20 from Merritt, British Columbia, various dates from 18-VII to 6-VIII-25, *Pinus ponderosa*, 17160, W. G. Mathers.

This species shares the same hosts and, presumably, has habits similar to those of *porosus* and *Hylastes macer* LeConte. It is widely distributed in the west and is common. It has been misidentified in collections as either *porosus* or *Hylastes macer*.

The holotype, allotype, and some paratypes are in my collection; other paratypes are in the collections of the U.S. National Museum, Canadian National Collection, California Academy of Sciences, and W. G. Harwood.

Pseudothysanoes brunneus, n. sp.

Diagnosis.—This species is allied to *sedulus* Blackman, but it is distinguished by the smaller size, by the more widely spaced strial punctures, by the more slender eyltral scales, and by the lighter body color.

Male.—Length 1.2 mm (paratypes 0.9-1.3 mm), 2.4 (female 2.7) times as long as wide; color brown.

Frons convex, a traverse impression just above epistoma; surface rather coarsely, closely, subrugulosely punctured; vestiture of moderately abundant, coarse, short setae. Scape very slightly longer than wide, as long as pedicel; club small oval, suture 1 indicated by setae only at sides, 2 weakly procurved.

Pronotum 0.86 times as long as wide; subcircular, anterior margin armed by about four to six small teeth; summit high, anterior slope asperate; posterior area shining, with fine, close punctures and granules. Vestiture of stout, rather short, moderately abundant setae.

Elytra 1.6 times as long as wide, 1.8 times as long as pronotum; sides almost straight and parallel on basal two-thirds, rather narrowly rounded behind; striae not impressed, punctures coarse, deep; interstriae narrower than striae, almost smooth, fine, uniseriate punctures on anterior half of disc, replaced by fine granules on posterior half. Declivity convex, steep; interstriae 1 slightly, 3 and 9 distinctly elevated, all interstriae with a row of fine granules. Vestiture of rows of fine, short, strial hair, and rows of erect interstrial scales; each scale two to three times as long as wide, shorter than distance between rows of scales or between scales within a row.

Female.—Similar to male except body more slender, 2.7 times as long as wide, scape very slightly wider, ornamented by a small tuft of hair; strial punctures much smaller, interstriae wider than striae and devoid of granules on disc; elytral scales about four to five times as long as wide.

Type Locality.—Miller Canyon, Huachuca Mts., Ariz.

Type Material.—The male holotype, female allotype, and seven paratypes were taken at the type locality on 10 July 1952, on *Quercus*. Two paratypes are from Madera Canyon, Santa Rita Mts., Ariz., 10 July 1952, on *Quercus;* and eight paratypes were taken 40 km (23 miles) south of Creel, Chihuahua, Mexico, on 18 July 1960, from *Quercus*, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Pseudothysanoes frondicolens, n. sp.

This species is allied to *crassinus* Wood, although it is not closely related. It is distinguished by the absence of interstrial granules in the male, by the impressed female frons, by the finer pronotal sculpture, and by the less abundant elytral vestiture.

MALE.—Length 0.9 mm (paratypes 0.8-1.2 mm), 2.1 (female 2.3) times as long as wide; color rather dark brown.

Frons flattened on lower third, convex above, with a conspicuously impressed median fovea; surface rather obscurely reticulate-granulate below, coarser above; vestiture of sparse, coarse hair. Antennal scape long, slender; club small, oval, sutures not indicated.

Pronotum 0.90 times as long as wide; subtriangular, widest near base, sides arcuately converging to narrowly rounded anterior margin; anterior margin armed by two, coarse, median teeth (four teeth present in some specimens); summit slightly behind middle, rather high and narrow; anterior slope rather coarsely asperate; posterior area very finely sculptured, almost smooth, sparse minute punctures. Vestiture sparse, short, rather fine.

Elytra 1.3 times as long as wide, 1.6 times as long as pronotum; sides almost straight and parallel on basal two-thirds, broadly rounded behind; surface usually covered by an incrustation; striae not impressed, punctures moderately coarse; rather shallow, not close; interstriae as wide as striae, evidently smooth, punctures fine, not at all granulate. Declivity occupying slightly more than posterior third, very broadly convex, rather steep; strial punctures larger than on disc; interstriae not at all granulate; somewhat flattened between interstriae 3, with suture feebly elevated on upper half. Vestiture of rows of fine, short strial hair, and rows of longer, erect interstrial scales; scales sparse, widely, irregularly spaced, each about four times as long as wide, apical part curved toward elytral apex; declivital interstriae 2 usually devoid of scales, 1 often with only one, 3 and 4 each with about three to five scales.

FEMALE.—Similar to male except body form more slender; frons irregularly concave on rather narrow triangular area from epistoma to vertex; anterior margin of pronotum armed as in male; strial punctures finer; elytral scales more slender, each about six times as long as wide, sparse but more regularly placed.

TYPE LOCALITY.—Herb Martyr Forest Campsite, Chiricahua Mts., Ariz.

TYPE MATERIAL.—The male holotype, female allotype, and 154 paratypes were taken at the type locality on 7 July 1969, 5800 ft elevation, from *Yucca* leaves, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Thysanoes berbericolens, n. sp.

This species is distinguished from the closely related *inornatus* Wood by the more extensively impressed female frons that is smooth

and polished to above the upper level of the eyes, by the unarmed anterior margin of the female pronotum, by the absence of interstrial granules on the disc, and by the more closely spaced interstrial scales.

Female.—Length 1.6 mm (paratypes 1.6-2.0 mm), 2.6 times as long as wide; color dark brown.

Frons shallowly concave from epistoma to slightly above eyes, upper fourth minutely punctured, smooth and shining, obscurely foveate at center. Scape as in *inornatus*.

Pronotum 0.96 times as long as wide; as in *inornatus*, except very broadly rounded in front; and posterior area obscurely, finely reticulate.

Elytra 1.7 times as long as wide, 1.9 times as long as pronotum; outline as in *inornatus;* striae not impressed, punctures rather small, impressed; interstriae twice as wide as striae, punctures fine, uniseriate, not at all granulate except at base of declivity. Declivity steep, convex; strial punctures minute to obsolete; interstrial punctures finely granulate. Vestiture of rows of fine strial hair, and interstrial rows of erect scales; each scale four to five times as long as wide; scales spaced within and between rows by distances equal to length of a scale.

Male.—Similar to female except frontal impression not as deep or as extensive; anterior margin of pronotum armed by six teeth; declivital strial punctures entirely obsolete; interstrial scales slightly shorter, each about four times as long as wide.

Type Locality.—Nogal Lake, Lincoln Co., N. Mex.

Type Material.—The female holotype and 20 paratypes were taken at the type locality on 1 June 1969, 7000 ft elevation, No. 30, from *Berberus fremontii* branches, by S. L. Wood. The male allotype and four paratypes were taken at the summit of Highway 380 about 10 miles southeast of Bingham, N. Mex., with the same date, host, and collector.

The holotype, allotype, and paratypes are in my collection.

Conophthorus cembroides, n. sp.

This species is closely related to *edulis* Hopkins, but it is distinguished by the slightly smaller, shallower punctures on the pronotum and elytra and by the flattened, very feebly impressed interstriae 2 on the declivity.

Male.—Length 2.3 mm (paratypes 2.2-2.5 mm), 2.2 times as long as wide; almost black, elytra dark reddish brown.

Frons as in *edulis*, with median epistomal tubercle very slightly larger, frontal punctures slightly smaller. Pronotum also as in *edulis* except punctures in posterior areas averaging much smaller and not as deep.

Elytra essentially as in *edulis* except strial and interstrial punctures on disc and declivity distinctly smaller; declivital interstriae 2 flat, very feebly impressed (somewhat variable in both species).

FEMALE.—Indistinguishable from the male by external characters.

TYPE LOCALITY.—Miller Canyon, Huachuca Mts., Ariz.

TYPE MATERIAL.—The male holotype, female allotype, and 15 paratypes were taken at the type locality on 8 August 1962, from cones of *Pinus cembroides*, by S. L. Wood. One specimen, not included in the type series, is labeled Zimapan, Hidalgo, Mexico, 12 June 1960, *Pinus cembroides* seed.

The holotype, allotype, and paratypes are in my collection.

Pityophthorus franseriae, n. sp.

This species has the pronotal asperities formed into three conspicuous concentric rows as in Blackman's Group II of this genus, but declivital striae 1 and 2 are entirely obsolete. Among described species it is unique.

FEMALE.—Length 1.3 mm (paratypes 1.2-1.3 mm), 2.7 times as long as wide; color very dark reddish brown, almost black, pronotal summit usually lighter.

Frons flattened on a rather narrow subcircular area; surface shining, rather finely, deeply, uniformly punctured; vestiture of very fine, comparatively short hair uniformly distributed, not longer or more abundant at margins. Antennal club small, oval, with two straight sutures dividing club into three subequal parts.

Pronotum 1.03 times as long as wide; widest behind middle, sides moderately arcuate on slightly more than basal half, rather broadly rounded in front; anterior margin armed by eight, subcontiguous, coarse teeth; anterior slope armed by three concentric rows of asperities; posterior area shining, punctures rather fine, deep, moderately sparse, median line impunctate. A few small setae at margins.

Elytra 1.6 times as long as wide; sides almost straight and parallel on basal three-fourths, abruptly rounded, then feebly acuminate at apex; striae not impressed, punctures rather coarse, deep; interstriae almost smooth, almost as wide as striae, impunctate. Declivity steep, very shallowly, broadly bisulcate; surface shining, impunctate; sutural interstriae distinctly elevated, 2 shallowly impressed, 3 weakly elevated, 2 and 3 each armed by widely spaced, very fine granules. Interstrial setae on declivital area fine, moderately long.

MALE.—Similar to female except frons with a well-developed transverse carina at vertex, fronal area slightly impressed, with moderately coarse punctures in lateral areas, vestiture less conspicuous, sparse.

TYPE LOCALITY.—Six miles west of High Rolls, Lincoln National Forest, N. Mex.

TYPE MATERIAL.—The female holotype, male allotype, and 56 paratypes were taken at the type locality on 2 June 1969, 6000 ft elevation, from *Franseria* stems, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Pityophthorus torridus, n. sp.

Superficially this species resembles *juglandis* Blackman, but it is larger, it has only three concentric rows of asperities on the pronotum, and it has declivital striae 1 and 2 almost obsolete.

Female.—Length 2.0 mm (paratypes 1.8-2.0 mm), 2.9 times as long as wide; color very dark reddish brown, almost black.

Frons broadly flattened from eye to eye, central half weakly concave; surface subshining, rather finely, uniformly, densely, deeply punctured; evenly, rather densely clothed by fine, long hair, setae near outer and upper margins slightly longer. Antennal club moderately large, oval, sutures straight; segment 1 longest.

Pronotum 1.1 times as long as wide; essentially as in *franseriae* Wood except anterior margin armed by 16 teeth and punctures in posterior areas finer.

Elytra 1.8 times as long as wide; sides straight and parallel on basal three-fourths, subacuminate behind; striae not impressed, punctures moderately coarse, deep; interstriae almost smooth, subshining, impunctate. Declivity steep, rather shallowly, broadly bisulcate; punctures of striae 1 and 2 very small, rather shallow; sutural interstriae moderately elevated, as high as lateral areas, interstriae 2 rather broadly, rather strongly impressed and impunctate, 1 and 3 each with a sparse row of pointed tubercles. Vestiture confined to posterior half, of rather coarse, moderately long hair of moderate abundance.

Male.—Similar to female except frons weakly convex, coarsely, sparsely punctured, vestiture sparse, inconspicuous, a very weak median carina on lower half; pronotal punctures distinctly larger.

Type Locality.—Six miles west of High Rolls, Lincoln National Forest, N. Mex.

Type Material.—The female holotype, male allotype, and three male paratypes were taken at the type locality on 2 June 1969, 6000 ft elevation, from *Franseria* stems, by S. L. Wood. These specimens were in the same stems with *franseriae* Wood.

The holotype, allotype, and paratypes are in my collection.

MAMMALIAN ECTOPARASITE CONSORTISM AT THE NATIONAL REACTOR TESTING STATION[1]

Dorald M. Allred[2]

Studies of ectoparasites of vertebrates at the National Reactor Testing Station in Idaho were conducted between June 1966 and September 1967. The host relationships, ecological and geographical distribution, seasonal occurrence and other biotic relationships of each of four major groups—ticks, fleas, mites, and lice—have been published (Allred 1968a, 1968b, 1970). The first article of that series discusses the physical characteristics of the station, study areas and procedures, and lists the vertebrates examined. This paper presents the interspecific and intergroup relationships between the eight most common species of these four major groups of ectoparasites found on the mammals.

The degree of compatibility between different species of ectoparasites is based on a negative correlation factor determined by the following formula:

$$\frac{\text{expected rate minus the actual rate}}{\text{expected rate}} = \text{negative correlation factor,}$$

where the expected rate equals the sum of the actual rates of infestation of the respective, individual groups. For example, only fleas were found on 14.9% and only lice on 0.7% of the kangaroo rats. Fleas and lice together were found on only 1.5% of the rats. Applying the above formula, fleas and lice together are expected to occur on 15.6% of the kangaroo rats. The difference between the actual (1.5%) and the expected (15.6%) is 14.1% which, when divided by 15.6% (the expected rate of infestation), yields a negative correlation factor of 90.4. The higher the correlation factor, the greater the competition between species, or the greater the significance of other factors of environmental resistance opposing their occurrence together.

Ectoparasite-Mammal Relationships

Fleas were found on mammals of more species than were other ectoparasites, whereas lice were found on the fewest (Table 1). On infested mammals, fleas were the most common ectoparasites on 15 species, ticks the most common on four, mites on one, and lice with fleas and mites with fleas were equally common on one species of host.

Fleas were found on mammals of all species except one, lice on all except six, mites on all except five, and ticks on all except four.

[1]BYU-AEC publication COO-1559-6.
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Table 1. Percentages of mammals infested with ectoparasites.

Mammal			%[2] of infested mammals[3] possessing:			
Species	No. examined	No. infested[1]	Fleas	Lice	Mites	Ticks
Canis latrans	6	5	100	0	0	0
Dipodomys ordii	808	743	72	15	46	65
Eutamias minimus	398	247	68	43	19	32
Lepus californicus	125	88	64	5	13	67
Lynx rufus	8	7	100	0	0	14
Marmota flaviventris	6	5	100	80	40	40
Microtus montanus	25	17	71	35	53	24
Mus musculus	1	1	100	0	0	0
Mustela frenata	4	4	50	0	0	100
Neotoma cinerea	14	14	100	13	33	47
Onychomys leucogaster	63	63	87	6	84	70
Perognathus parvus	474	318	38	8	29	68
Peromyscus maniculatus	1866	1629	82	30	37	40
Plecotus townsendii	78	43	0	0	100	0
Reithrodontomys megalotis	39	18	72	11	11	22
Sorex merriami	9	1	100	0	100	0
Spermophilus townsendii	60	43	65	65	28	40
Sylvilagus idahoensis	13	11	82	9	9	27
Sylvilagus nuttallii	28	23	83	4	28	39
Taxidea taxus	5	3	33	67	0	100
Thomomys talpoides	8	8	88	13	63	13
Vulpes fulva	4	3	100	0	0	0
Total species infested		22	21	15	16	17

[1]With any of the 4 kinds of ectoparasites listed.
[2]Nearest whole percent.
[3]Those infested with any kind of ectoparasite.

Ectoparasite Compatibility on Common Mammals

Relative degrees of ectoparasite and host compatibility are shown in Table 2. Fleas on kangaroo rats, chipmunks and deer mice, lice on kangaroo rats and pocket mice, mites on chipmunks, and ticks on deer mice and pocket mice apparently were the least compatible combinations.

Intergroup compatibility of ectoparasites is shown in Table 3. On kangaroo rats the most compatible ectoparasites were fleas with ticks; on chipmunks, lice with ticks; on pocket mice, mites with ticks; and on deer mice, fleas with mites. Greatest incompatibility on these hosts occurred between fleas, lice and ticks on kangaroo rats, mites and ticks on chipmunks, and lice, mites, and ticks on pocket mice and deer mice.

Compatibility between the common species of ectoparasites is shown in Table 4. Chigger mites of *Euschoengastia decipiens* were the least compatible with any other single species, whereas lice of

Table 2. Ectoparasite group isolation on commonly-collected mammals of four species.

Host	%[1] of mammals[2] infested only with:			
	Fleas	Lice	Mites	Ticks
Dipodomys ordii	15	1	5	12
Eutamias minimus	32	12	4	8
Perognathus parvus	16	3	7	37
Peromyscus maniculatus	24	3	3	6

[1]Nearest whole percent.
[2]Of those infested with some kind of ectoparasite.

Table 3. Association relationships between groups of ectoparasites on commonly-collected mammals of four species.

Ectoparasite association	Species and negative correlation factor[1]			
	D. ordii	*E. minimus*	*P. parvus*	*P. maniculatus*
Fleas-lice	90	78	97	72
Fleas-mites	54	90	80	54
Fleas-ticks	15	79	77	47
Lice-mites	86	80	90	68
Lice-ticks	89	77	95	84
Mites-ticks	63	100	69	83
Fleas-lice-mites	85	94	99	81
Fleas-lice-ticks	94	88	99	86
Fleas-mites-ticks	50	96	96	78
Lice-mites-ticks	89	97	100	93
Fleas-lice-mites-ticks	88	94	99	90

[1]Equals the expected rate of infestation (sum of the actual rates of infestation of the respective individual groups) minus the actual raee of infestation, divided by the expected rate of infestation. The higher the number the more negative the association.

Table 4. Association relationships between combinations of specific ectoparasites[1] on mammals.

Ectoparasite	Combination and negative correlation factor[2]	
	With 1 other ectoparasite	With 2 other ectoparasites
Fleas		
Meringes parkeri	81	197
Monopsyllus wagneri	50	111
Lice		
Polyplax auricularis	80	240
Mites		
Eubrachylaelaps debilis	59	102
Euschoengastia decipiens	102	181
Haemolaelaps glasgowi	39	64
Ticks		
Dermacentor andersoni	79	183
Ixodes kingi	62	136

[1]Only commonly-collected species.
[2]Equals the expected rate of infestation (sum of the actual rates of infestation of the respective individual groups) minus the actual rate of infestation, divided by the expected rate of infestation. The higher the number, the more negative the association.

Polyplax auricularis were the least compatible when more than one other species was involved. *Polyplax auricularis* was the least compatible of all species associations, and the mite *Haemolaelaps glasgowi* the most.

Species Consortism

Ticks of *Dermacentor andersoni* and fleas of *Meringes parkeri* were found alone on their hosts a greater percentage of the time than were other species (Table 5). Mites of *Eubrachylaelaps debilis* were associated with other ectoparasites more than any other species. The most frequent associations occurred between ticks of *Ixodes kingi* and fleas of *Meringes parkeri*. In fact, sufficiently low negative correlation factors occurred between these latter two species and between *Polyplax auricularis* and *Eubrachylaelaps debilis* in comparison to other combinations to suggest a positive interrelationship. However, when a third species is considered in these associations, the negative correlation factors increase considerably, except for the combinations of *Polyplax-Eubrachylaelaps-Monopsyllus wagneri*, and *Ixodes-Meringes-Haemolaelaps glasgowi* wherein the negative correlation factors were the lowest of any triple combinations.

In the nine combinations of four species, seven negative correlative values were over 99%, and two were 97% and 98%. Apparently when four groups are involved, too much competition is present to permit frequent infestations by so many different groups.

Table 5. Consortism between species of major groups of some common ectoparasites on mammals.

Parasite Association	%[1] times occurred: As only common[2] ectoparasite	With ectoparasite indicated
Dermacentor andersoni	18	
Eubrachylaelaps debilis		2
Euschoengastia decipiens		1
Haemolaelaps glasgowi		5
Meringes parkeri		11
Monopsyllus wagneri		5
Polyplax auricularis		2
Eubrachylaelaps debilis	3	
Ixodes kingi		2
Meringes parkeri		1
Monopsyllus wagneri		7
Polyplax auricularis		6
Euschoengastia decipiens	14	
Ixodes kingi		2
Meringes parkeri		1
Monopsyllus wagneri		1
Polyplax auricularis		1
Haemolaelaps glasgowi	5	
Ixodes kingi		5
Meringes parkeri		6
Monopsyllus wagneri		8
Polyplax auricularis		3
Ixodes kingi	14	
Meringes pargeri		18
Monopsyllus wagneri		8
Polyplax auricularis		3
Meringes parkeri	18	
Polyplax auricularis		1
Monopsyllus wagneri	16	
Polyplax auricularis		8
Polyplax auricularis	6	

[1]Nearest whole percent. 1% indicated if less than 0.5%.
[2]Of the 8 listed in this table.

Conclusions

Negative consortism occurs between different groups of ectoparasites on the mammals at the NRTS. Only two of the 11 combinations on four common mammals (total of 44 groupings) had negative

correlation factors of less than 50. The lowest negative factor of any ectoparasite was for the mite *Haemolaelaps glasgowi* which is the most ubiquitous of all the species studied. The parasite with the highest factor was the louse *Polyplax auricularis* which belongs to the most host-specific group of the four categories of ectoparasites studied.

Of those ectoparasites which occurred as the only single group on their hosts, the fleas were predominant on three of the four common species of mammals, ticks on the other. Lice occurred alone most infrequently of the ectoparasite groups in all cases except one when they surpassed both the mites and ticks as single-occurring ectoparasites.

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NOTES ON THE WINTER FOOD OF SCREECH OWLS IN CENTRAL UTAH

Dwight G. Smith[1] and Charles R. Wilson[2]

During the winter season of 1968-69, pellets were collected from beneath several roosting sites of a single screech owl (*Otus asio*) in central Utah. The roosts were located among the buildings of the abandoned Ironton Steel Mill in Springville, Utah. The 500-acre steel mill property includes over 60 buildings and is surrounded by open areas of marsh, grassy fields, and several small, shallow ponds. Very few trees are present in the immediate area. The winter bird populations in and around the mill consisted almost entirely of pigeons (*Columba livia*), starlings (*Sturnis vulgaris*), and house sparrows (*Passer domesticus*). Mammals trapped or observed included deer mice (*Peromyscus maniculatus*), house mice (*Mus musculis*), meadow mice (*Microtus pennsylvanicus*), and vagrant shrews (*Sorex vagrans*). Two pairs of barn owls (*Tyto alba*) were present within the territorial area utilized by the screech owl. These owls occupied their territory throughout the year, but the screech owl apparently left the mill area in mid-March and was not observed in the vicinity again.

A total of 67 pellets was collected during January, February, and early March. Pellet analysis followed standard techniques described by Errington (1930), and results are presented in Table 1. The approximate prey weights used in the biomass determinations were obtained from Craighead and Craighead (1956) and Marti (1969).

Pellets contained from one to four prey individuals but averaged only 1.1 individuals per pellet. They yielded a total of 80 prey individuals of which 24.9% were mammals, 51.3% were birds, and 23.8% were insects. Three mammal, two avian, and three insect

Table 1. Winter contents of Screech Owl pellets near Springville, Utah.

Prey Species	No. Indv.	% Indv.	Biomass in gms.	% Biomass
Microtus pennsylvanicus	14	17.5	630.0	28.2
Peromyscus maniculatus	5	6.2	105.0	4.7
Sorex vagrans	1	1.2	13.0	0.6
Passer domesticus	37	46.3	1110.0	49.6
Sturnis vulgaris	4	5.0	376.0	16.8
Carabidae	2	2.5	0.5	Tr*
Tenebrionidae	4	5.0	2.2	0.1
Forficula auricularia	13	16.3	1.3	Tr.
Totals	80	100.0	2238.0	100.0

*Present in trace amounts only.

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forms were identified. The major component of most pellets, and the most frequently taken prey species, was the house sparrow, although meadow mice and European earwigs were also present in many pellets.

A review of previous literature on screech owl predation suggests that the prey species found in this study fall within the variety of prey previously recorded for this owl with the exception of the earwigs (*Forficula auricularia*), which appear to be reported herein for the first time. The utilization of vertebrates is comparatively high and seems to support Johnson's suggestions that the more northern screech owls prey heavily on vertebrates during winter when insect food is scarce, contrasting with the more insectivorous southern screech owls (Johnson, 1963; Earhart and Johnson, 1970).

We conclude that our observations lend support to this possibility and we feel that the screech owl is probably a relatively opportunistic predator, preying on the most easily and efficiently obtainable prey.

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CONIFERS OF THE BEAR LAKE AREA AND MOUNTAINS SOUTH OF THE GREAT SALT LAKE[1]

Ronald M. Lanner[2]

As Critchfield and Allenbaugh (1969) have pointed out, much remains to be learned of the distribution of conifers in the Great Basin region. The same is true of many other areas elsewhere in the West. Current research at Utah State University is designed to provide new distribution data through systematic surveys of areas that have received little attention from botanists and foresters.

Typical of such areas are the contiguous parts of Utah, Idaho, and Wyoming that comprise the Bear Lake Plateau and the Bear River Divide; and the complex of mountains immediately south of the Great Salt Lake.

This report deals with the conifer flora of those areas. The occurrence of previously unrecorded species is supported by specimens deposited in the Intermountain Herbarium at Utah State University, Logan, Utah (UTC), though individual collections are not cited in the text.

The Bear Lake Plateau

This plateau lies immediately to the east of Bear Lake. It is bounded on the east and north by the meandering Bear River which is paralleled by the Union Pacific tracks and by U.S. Highway 30N from Sage, Wyo., to Alton, Idaho. Its southern boundary is considered here to be Utah Highway 16 from Laketown to Sage Creek Junction. It comprises an area of approximately 240 square miles, including portions of Rich County, Utah; Bear Lake County, Idaho; and Lincoln County, Wyo.

The plateau rises sharply above Bear Lake (elevation 5924 ft) to elevations of 7500-7800 ft within a mile of the shoreline. The plateau is dissected on the west side by several short steep canyons draining into Bear Lake. The east slope is drained by a series of intermittent streams.

The steep west-facing slope is dotted with Utah juniper (*Juniperus osteosperma* [Torr.] Little) scattered on rocky ground covered largely by sagebrush and grass. In the smaller ravines where a northerly aspect affords shelter, the juniper is associated with Rocky Mountain maple (*Acer glabrum* Torr.), serviceberry (*Amelanchier* sp.), mountain mahogany (*Cercocarpus ledifolius* Nutt.) and chokecherry (*Prunus virginiana* L.).

In South Eden Canyon narrow-leaved cottonwood (*Populus angustifolia* James) and aspen (*P. tremuloides* Michx.) occur in the stream bottom; clones of aspen are also common in sheltered draws

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to over 7000 ft. Utah juniper is the only conifer in South Eden Canyon except for two subalpine firs (*Abies lasiocarpa* [Hook.] Nutt.). These trees were growing 0.8 mile apart at about 6600 ft in moist draws on the north-facing slope of the canyon. They probably grew from windborne seed originating in the Bear River Range across Bear Lake, at least 10 miles to the west.

The top of the plateau is treeless except for scattered aspen trees. On north-facing slopes are scattered Utah junipers, and about 3 miles south of Pegram, Idaho, an isolated all-aged stand of Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco). This stand is on a north-facing slope and extends from about 6150 to 6600 ft. Cone-bearing is heavy in this stand. Despite its isolation, many of the trees show prominent signs of porcupine injury.

In North Eden Canyon, and in a nameless canyon about 7 miles to the north, mixed stands of Rocky Mountain juniper (*J. scopulorum* Sarg.) and Douglas-fir occur on north-facing slopes between 6000 and 6500 ft. Some of the associated angiosperms, especially in the stream bottoms, are chokecherry, quaking aspen, box elder (*Acer negundo* L.), mountain mahogany, and willows (*Salix* spp.).

The Bear River Divide

The Bear River Divide lies southeastward of the Bear Lake Plateau. It comprises an area of about 1000 square miles, mostly in Lincoln and Uinta counties, Wyo., with a small part (Crawford Mountains) in Rich County, Utah. It is bounded on the west by the Bear River; on the north from Sage to Kemmerer, Wyo., by U.S. Highway 30N and the Union Pacific tracks along Twin Creek; and on the east and south by U.S. Highway 189 from Kemmerer to Evanston, Wyo.

Most of the divide area consists of high, rolling, sage-covered hills reaching as high as 8242 ft in the north (Elk Mountain) and about 8640 ft in the south (Medicine Butte). The steepest slope is the western scarp of the Crawford Mountains, which rises above the Bear River from about 6200 ft to over 7800 ft east of Randolph, Utah (Rex Peak).

On the west scarp of the Crawford Mountains, Rocky Mountain juniper, Utah juniper, and Douglas-fir are found on north-facing slopes from about 6600 ft to 7800 ft. In some of the steep box canyons below Rex Peak, both pinyon (*Pinus edulis* Engelm.) and singleleaf pinyon (*P. monophylla* Torr. and Frém.) are found in association with Rocky Mountain and Utah junipers, Douglas-fir, and mountain mahogany. This is the most northerly stand of pinyon yet reported (Critchfield and Little, 1966). It consists of trees of all ages, including seedlings, between 6800 and 7700 ft. Most of the trees appear to be pure pinyon, but many show evidence of hybridization with singleleaf pinyon. A detailed treatment of this and other stands of hybridizing pinyon pines is now in preparation.

Thickets of aspen and chokecherry are found on the exposed ridge tops around Rex Peak. Scattered aspen clones, chokecherry,

and mountain mahogany form the only tree cover over large areas in the interior of the divide, especially on Elk Mountain and in shallow ravines, as on Medicine Butte.

Just outside the eastern boundary of the area, Douglas-fir is found on Oyster Ridge east of Albert Creek. On steep rocky slopes south of Elkol, Wyo. (about 7 miles SW of Kemmerer), limber pine (*P. flexilis* James) is found with Rocky Mountain juniper.

Douglas-fir and limber pine also occur on north-facing slopes from Kemmerer west to Nugget between 6800 ft and 7400 ft.

Just north of the divide area in Schuster Basin (about 6 miles N of Fossil Station), Engelmann spruce (*Picea engelmannii* Parry) is found along streams. On the slopes above are found Douglas-fir, limber pine, and Rocky Mountain juniper associated with aspen.

Stansbury Island

Stansbury Island is connected to the south shore of Great Salt Lake by a causeway across the salt flats. It consists of a single range of steep rocky hills rising to a maximum elevation of 6645 ft. The only conifer species found on the island was Utah juniper (*Juniperus osteosperma* [Torr.] Little), which occurs from the edge of the salt flats (ca. 4300 ft) to over 6600 ft.

The Stansbury Mountains

The Stansbury Mountains are typical of Great Basin ranges. They extend south from Timpie for about 30 miles to Johnson Pass (Utah Highway 215). They are oriented north-south and rise abruptly from the desert floor on either side. To the east lie Tooele Valley and Rush Valley with elevations ranging from 4500 to 5500 ft. To the west is Skull Valley where elevations range from 4200 to 4800 ft. The highest point in the range is Deseret Peak (11,031 ft); several other peaks exceed 10,000 ft. Most of this area is in the Wasatch National Forest.

The dry west-facing slope is thinly forested with scattered Utah junipers. In Dry Canyon, which extends east of the Skull Valley Indian Reservation, this juniper is associated with singleleaf pinyon from 6100 to 7100 ft. The singleleaf pinyons are mainly restricted to north-facing slopes and the canyon bottom. Near their upper altitudinal limits they are associated with limber pine and white fir *Abies concolor* (Gord. and Glend.). According to local residents, singleleaf pinyons occur in other canyons on the west side of the range; and in a small canyon just south of South Willow Canyon (on the east side) as well.

Forest cover is much heavier on the east side of the range, especially in the canyon bottoms and on north-facing slopes where Douglas-fir predominates.

The most luxurious vegetation is found in South Willow Canyon, and includes, at about 6000 ft, Utah juniper, narrow-leaved cottonwood, chokecherry, bigtooth maple (*Acer grandidentatum* Nutt.),

Douglas-fir, box elder, and aspen. At about 6500 ft white fir becomes common in stream courses, and there are occasional limber pines and Rocky Mountain junipers.

At comparable elevations in the Mining Fork of South Willow Canyon and in North Willow Canyon, most of the same species are present.

Below the Lower Narrows of South Willow Creek, on a brushy north-facing slope above a Boy Scout camp, were about a score of living and dead ponderosa pines (*P. ponderosa* Laws.) and two lodgepole pines (*P. contorta* Dougl.). These pines ranged in age to about 28 years and most had been injured or killed by porcupines. No seed trees were found that might have been the progenitors of these saplings, despite a careful search of the mountainside and surrounding area. The nearest known natural stands of both species lie at least 50 miles distant in the Wasatch Range (Critchfield and Little, 1966), and it is probable that these trees were planted.

Further up South Willow Canyon the predominating species is Douglas-fir. White fir is common in moist streamside habitats. Between 7600 and 8000 ft, along the trail to Deseret Peak, limber pine, subalpine fir, Engelmann spruce, and Rocky Mountain juniper are associated with white fir, Douglas-fir, and aspen. Engelmann spruce becomes the dominant species in the upper reaches of Mill Fork.

Above 10,000 ft there is frequent *krummholz* of Engelmann spruce, limber pine, subalpine fir, and even Douglas-fir, with occasional mats of prostrate *Juniperus communis* L. The summit of Deseret Peak is treeless.

On the north sides of high ridges extending west from Deseret Peak are further stands of Engelmann spruce. At its lower limits this forest merges into mixed stands similar to those in upper South Willow Canyon; and this forest merges into the drier west-slope type described above.

Along the south edge of the Stansbury Mountains the relatively low dry hills are covered by extensive stands of Utah juniper. In the bottom of Clover Creek (in Johnson Pass) are box elders, narrow-leaved cottonwoods, and aspen.

The Onaqui Mountains

This range extends from Johnson Pass southward for about 15 miles to Lookout Pass, through which runs the old Pony Express Route. Its highest point is a nameless peak that reaches 9067 ft. These mountains are nearly treeless, the arboreal vegetation being confined to north-facing slopes of canyons and beds of the intermittent streams. The only conifer species identified, by telescopic examination, was Douglas-fir.

The Sheeprock Mountains

The Sheeprocks curve southeastward from Lookout Pass and extend for about 20 miles to Sabie Mountain (8016 ft) and the heads

of Vernon and Cherry Creeks. Beyond Cherry Creek rise the West Tintic Mountains.

The major part of the Sheeprocks lies within the Vernon Division of the Wasatch National Forest. Its highest points are a nameless peak (9273 ft) and Dutch Peak (9154 ft). Large areas are treeless, except for Utah juniper, even on the highest points. In Harker Canyon at 6200 ft, Utah juniper was collected; and at 7300 ft, Douglas-fir and aspen were found on north-facing slopes. Singleleaf pinyon was collected at 6200 ft in Bennion Creek, where it was associated with Utah juniper.

The West Tintics and Boulter Mountains

The West Tintics are a poorly differentiated range of hills lying east of the Sheeprocks and oriented roughly in a north-south direction. Their northward extension is known as the Boulter Mountains or East Tintics. From Lofgreen south into Juab County are extensive stands of singleleaf pinyon and, less commonly, scattered individuals of pinyon. Examination of this stand and others nearby has disclosed what appears to be a hybrid swarm of these two pine species, including putative F_1 hybrids and backcross and introgressant segregates. Evidence of hybridization was also noted on the west slope of the Boulter Mountains (Scranton and Blackrock canyons) and on the east slope (Barlow and Broad canyons), though to a lesser degree. This situation is similar to that in Rich County and to other hybrid pinyon zones extending in a belt from Cache County into Arizona. In an earlier study, Cole[3] reported on a hybrid pinyon population on nearby Sabie Mountain in the Sheeprocks. The hybrid stands mentioned here, and evidence of intergradation in areas inhabited by either pinyon species, will be reported upon in detail elsewhere.

At the upper limit of its distribution in Blackrock Canyon, at about 7500 ft, singleleaf pinyon is associated with chokecherry, subalpine fir, Douglas-fir, and Rocky Mountain juniper.

Acknowledgment

Norman Channing, Ronald Warnick, and David A. Van Den Berg assisted in the field work. District Ranger Burt Rouse, Wasatch National Forest, provided information on distributions in the Stansbury Mountains.

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DESCRIPTION OF A NEW SPECIES OF *DALEA* (LEGUMINOSAE) FROM UTAH

Stanley L. Welsh[1]

During the spring of 1966, a collection of plants taken in San Juan County, Utah, yielded an unusual white-flowered specimen of *Dalea*. The specimen belongs to that section of *Dalea* traditionally ascribed to the genus *Petalostemon*, and after casual investigation it was identified as *Petalostemon flavescens* and filed in the general herbarium at Brigham Young University (BRY). A careful review of the species of *Dalea* and *Petalostemon* demonstrated that the *Dalea* specimen was distinguishable from both *Petalostemon flavescens* Wats. and *P. occidentale* (Heller) Fern., the only other white-flowered species known from Utah, on the basis of thicker spikes and larger flowers. Indeed, the specimen indicated quite another line of relationship, i.e., with *Petalostemon ornatum* Dougl. ex Hook. (including *P. searlsiae* Gray). In Utah, *P. ornatum* is known only from west of the Colorado River, and, additionally, it has pink flowers which average smaller, and has more slender spikes.

In 1970, two visits were made to the site of the original discovery. Additional specimens were collected, and the extent of the population was investigated. The population occurs on sandstone bedrock and to a lesser extent on dune sands. It grows along the Halls Crossing road for a distance of about 10 miles, beginning at a point about 2 miles west of the junction of the Wilson Mesa road. Its occurrence along a north-south line was observed to be at least one-half mile. A new highway is being constructed through the apparent center of the population.

The species is named in honor of the journey of the heroic Hole-in-the-Rock pioneers who passed nearby in late February of 1880.

Dalea epica Welsh, sp. nov.

Fig. 1

A *D. flavescenti* differt spicis longioribus et latioribus et floribus magnioribus, et a *D. ornatis* differt spicis longioribus et latioribus et floribus magnioribus et albis.

Caudex ligneus valde, ramificans subterraneus aliquantus; caules a aliquot ad numerosus (20) 25-35 (42) cm longus, strigulosus; stipulae lanci-subulatae, 2-4 mm longae, persistentes; folia 1.5-3.8 cm longa; foliola 5, 5-19 mm longa 2-7 (9) mm lata, plicata vel plana, strigulosa, glandulosi-punctata; a oblanceolata ad elliptica, acuta; pedunculus 1.4-9 (12) cm longus; spica (2) 2.5-9 (14) cm longa, 1.2-1.8 cm lata (ubi complanata), subcylindrica; bractae 4-6 (7) mm longae, lanci-aristatae, villosae; flores 7.5-11 mm longi, subsessiles;

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Fig. 1. *Dalea epica* Welsh sp. nov.

calyx 5-7 mm longus, dentes 2.7-4 mm longus, tubus 3 mm longus; petala alba, calyx excedens; pistilla 12.5 mm longa, stylus 9 mm longus; fructus immaturus, 3.5-4 mm longus, 1.5-2 mm latus, pilosus.

Utah: San Juan Co., Plateau, ca 10 miles east of Halls Crossing, in sandy soil, in Blackbrush community, on Kayenta Formation, S. L. Welsh 5205, 30 April 1966 (Holotype, BRY, Isotype NY). Navajo blow sand and bedrock, with blackbrush, sagebrush, cryptantha, and hymenopappus, ca 2 miles west of road to Wilson Mesa, on Halls Crossing road, S. L. Welsh 9818, 16 May 1970 (BRY); do, S. L. Welsh and N. D. Atwood 9990, 6 June 1970 (BRY); do, S. L. Welsh and N. D. Atwood 9994, 6 June 1970 (BRY).

SIGNIFICANCE OF THE LATE PLEISTOCENE FAUNA FROM THE LITTLE BOX ELDER CAVE, WYOMING, TO STUDIES OF ZOOGEOGRAPHY OF RECENT MAMMALS

Charles A. Long[1]

Abstract.—A late Pleistocene mammalian fauna from Little Box Elder Cave, eastern Wyoming, provides paleontological evidence bearing on several contemporary and related studies in zoogeography of Recent intermontane mammals and on understanding of rapidly changing environments in the Rockies in late Pleistocene and post-Pleistocene time. Both paleontological and zoogeographical findings suggest that during glacial periods in the Pleistocene the life-zones were lowered and, therefore, many boreal mammals ranged away from the glaciated Rocky Mountain chain. Since then, some of these returned or retreated northward as the climate moderated, and many warmth-adapted mammals approached the Rockies. The fossil and Recent faunas analyzed together reveal that the post-Pleistocene climate became so warm that numerous boreal species disappeared from habitats that are now again boreal (montane). Some warmth-adapted species have advanced to and retreated from the cave area. The climatic optimum, as well as the glacial and interglacial periods, apparently affected the distribution of numerous mammals in this area.

Introduction

The Central Rockies and the lower, warmer prairies of the Great Plains to the eastward have been intensively investigated by biologists and geologists. The biologists have ascertained the geographical distribution of much of the Recent biota, and the geologists, especially the Pleistocene geomorphologists, have postulated a climatic history for this region. However, a great hiatus in the evidence available for zoogeographical studies of intermontane mammals has been the paucity of information on late Pleistocene fossil deposits in this region.

A faunal list (Anderson, 1968), completed it seems in 1964, records late Pleistocene mammals from Little Box Elder Cave, Converse County, Wyo., and substantiates and augments several contemporary studies on the zoogeography of Recent mammals. The fossil remains from this cave are discussed below concerning the distribution and speciation of mammals of the Central Rockies, the Black Hills, the Bighorn Mountains, the northern ranges of the Southern Rockies, and the plains of eastern Wyoming and western Nebraska.

General Ecology and Mammalian Zoogeography of the Region

The habitat at Little Box Elder Cave is semiarid; the vegetation is reportedly comprised of sagebrush, grama grasses, ponderosa (yellow) pine, narrow-leafed cottonwood, box elder, mountain mahogany, skunk-brush (*Rhus trilobata*), poison oak, prickly pear, and lichens (Anderson, 1968:51). This habitat would be in the Transition Life-zone judging from such plant indicators as sage, yellow pine, and

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narrow-leafed cottonwood (Cary, 1917). The cave is in the Laramie Mountain system, some peaks of which are covered by coniferous forest. Long (1965:725) ascribed the forested hills near the cave to the Laramie Mountains Faunal Subdivision, the warm lowlands to the Cheyenne Plains Faunal Division of the Great Plains Faunal Area (see below). Clark (1970) recently discussed the ecology of this semiarid division.

The general ecology of Wyoming was discussed by Merrit Cary (1917) and reviewed by Long (1965). The life-zone concept clarifies the profound effects of temperature ranging from the cold, wet Arctic-alpine Life-zone down to the hot, arid Upper Sonoran Life-zone. The highest elevation in Wyoming is 13,785 ft, and the lowest 3100 ft, in the valley between the Bighorn Mountains and the Black Hills. The annual precipitation varies from well over 20 inches in the western and southern mountains to less than 10 inches in the lowest valleys and basins. An elevated base level in Wyoming, about 6000 ft, is related to generally cool climate, averaging 10 F cooler in the mountain valleys than on the plains.

The differential effects of climate categorized by the life-zones in Wyoming are reflected in the vegetation zones (Cary, 1917; Long, 1965). Many Wyoming mammals (especially subspecies) show association with either boreal or lowland plants. The boreal habitats in the Central Rockies today are confined to the high mountain ranges and comprise the forested Canadian and higher life-zones (Fig. 1). Sage, grasses, yellow pine, and other plants of the lowlands indicate the Transition and lower life-zones.

Owing to weaknesses in the life-zone concept (see Kendeigh, 1954; Long, 1965), it was augmented in Wyoming (Long, 1965) by the concept of faunal areas and their subdivisions based on mammalian distributions (Fig. 2). Faunal areas were used by Grinnell (1914) to depict natural faunistic assemblages delimited by relative humidity. This concept was modified by Durrant (1952) to categorize areas simply by the presence or absence of certain mammals. Durrant's approach explains the composition of faunas that reflect both present and past environmental factors, and his method has been used by several workers in the intermontane states.

The geographical ranges of mammals of Wyoming were ascertained (Long, 1965) by study of nearly 13,000 preserved specimens. Jones (1964) determined the geographic distributions of nearby Nebraskan mammals after studying thousands of specimens over a period of 15 years. The concept of faunal areas in the cave area rests on a basis of intensive and long-continued field investigation.

Most of the high mountains in Wyoming lie along or west of the Continental Divide and comprise the Rocky Mountain Faunal Area (Fig. 2). The mountains for the most part are massed in both northwestern and south-central Wyoming. An arid, low discontinuity between these mounainous areas includes the Central Portal Faunal Area and the Upper and Lower Green River divisions (of the Rocky Mountain Faunal Area). The Great Plains, found eastward of the Rockies, comprise the Great Plains Faunal Area. The plains isolate

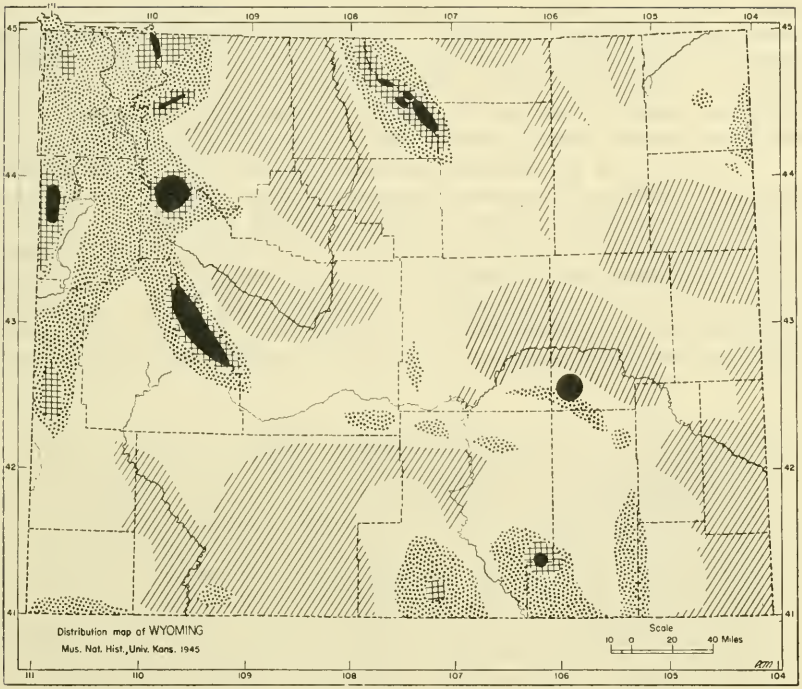

Fig. 1. Geographic distribution of life-zones of Wyoming. Black areas, Arctic-alpine. Hatched areas, Hudsonian. Stippled areas, Canadian. Clear areas, Transition. Lined areas, Upper Sonoran. The black dot is the locality of Little Box Elder Cave.

the Bighorn Mountains, and especially the Black Hills, from the Rocky Mountain chain. Some lowland species and subspecies range across the Continental Divide through the low Central Portal Faunal Area. The Wyoming faunal divisions and subdivisions (Fig. 2) and the mammals that inhabit them are more fully discussed by Long (1965:726-729). The Wyoming mammalian fauna consists primarily of montane species and subspecies more or less restricted to the Rocky Mountain Faunal Area, and of lowland species and subspecies inhabiting the deserts and basins in the west and the tremendous grassy prairies in the east.

When patterns of Recent distribution are found that are inconsistent with the ecological distributions resulting from the prairies and mountains, the reason may be that some ecological conditions today are different from those in the Pleistocene. Analysis of past climate provides understanding of the former environments and hence of unusual Recent patterns of mammalian distribution.

The history of climatic conditions in the Central Rockies is known, for the most part, from studies of past glaciations. The evidences were reviewed by Long (1965), Ray (1940), Holmes and

Moss (1955), and others. Briefly, the climate varied from cold, wet periods when glacial ice scoured the mountains and deposited moraines to warm, dry periods resembling present time when the ice receded or disappeared. The distances between cirques and terminal moraines reveal the extent of past glaciation, and the erosion of the moraines permits them to be correlated in regard to approximate age.

In general, the glaciations represented by moraines in the Rockies became decreasingly severe. Some inextensive formation of glacial ice has been aged as Recent, beginning about 2000 years ago, and numerous glaciers exist today especially in the Wind River Mountains (Wentworth and Delo, 1931). In the Central Rockies generally only the ancient and highest (Hudsonian and Arctic-alpine life-zones) mountain systems were glaciated (Fig. 1), although during early (severe) glaciations ice tongues descended into the lowlands

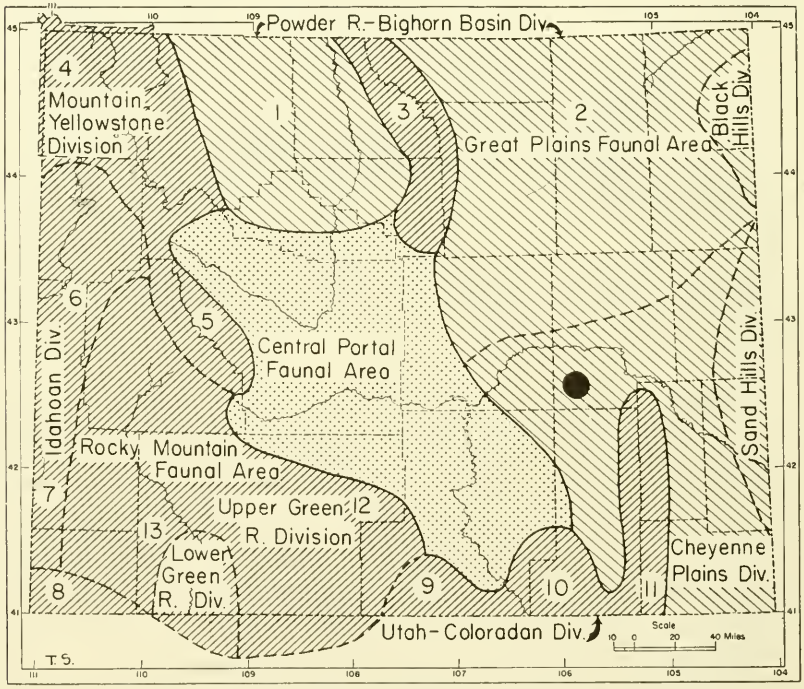

Fig. 2. Faunal Areas and Faunal Divisions of Wyoming (from Long, 1965). The dot shows the location of Box Elder Cave. Faunal areas are Rocky Mountain, Great Plains, and Central Portal. The Black Hills, Sand Hills, and Cheyenne Plains divisions are mentioned in the text, and the faunal subdivisions mentioned in this paper are identified as follows:

2 Powder River
3 Bighorn Mountains
5 Wind River Mountains
8 Uinta Mountains
10 Medicine Bow Mountains (=Snowy Range)
11 Laramie Mountains
13 Upper Green River

east of the Wind River and Absaroka ranges, into Jackson Hole, around the Bighorn Mountains, and north of the Uinta Mountains (Fig. 2). Low margins of glaciation were 6200 ft in the Bighorn Mountains, 8100 ft in the Medicine Bow Mountains, and 7500 ft in the Cache la Poudre area in Colorado. The Arctic-alpine Life-zone was perhaps several thousand feet lower than at present, and the other life-zones likewise were lower or absent.

Mammals now confined to montane areas probably dispersed freely (except on the ice masses and snowfields) when cool habitats were more extensive. These boreal mammals probably followed the rising life-zones upward in the montane areas during warming trends and were then replaced in the warm, arid lowlands by warmth-adapted species. These doubtless came from refugia eastward (e.g., *Lepus californicus*, Fig. 3) and westward of the Rocky Mountains. Some boreal species (e.g., *Gulo*, *Erethizon*) perhaps lived in Wyoming even during severe glaciations (Long, 1965).

The montane populations isolated today are not the only distributions that indicate lowered life-zones in the past, but they are the most impressive. The snowshoe hare, *Lepus americanus seclusus*, of the forested Bighorn Mountains (Fig. 3) shows stronger affinity to *L. a. americanus* occurring far to the northward than to the nearby *L. a. bairdii* of the Rockies (Baker and Hankins, 1950; Long, 1965). A relict population of golden-mantled ground squirrel, *Spermophilus lateralis lateralis*, occurs in the southern Wind River Mountains (Fig. 2) and intergrades with *S. l. castanurus* northward (Fig. 4). *S. l. lateralis* is widespread in the mountains southward beyond the arid Upper Green River Faunal Division in southern Wyoming and in Colorado. This discordancy in the distribution of *S. l. lateralis* suggests that its habitat was formerly more continuous from the Wind River Mountains into Colorado.

A pollen record (Hansen, 1951) reveals that in postglacial time the now warm Upper Green River Faunal Division was forested with boreal conifers, which were replaced by grasses, composites, and sage. *S. l. wortmani* occurs today in this arid area in suitable habitat (conifers on the north slopes of buttes). This subspecies closely resembles *S. l. lateralis* except for much paler pelage. Pale pelage is characteristic of many desert mammals (Gloger's Rule). Spruce forest also occurred lower than at present east of the Rockies, in the Nebraskan sandhills, approximately 12,600 years ago (Watts and Wright, 1966).

If the distributions (Figs. 3, 4) of *Lepus americanus* and *Spermophilus lateralis* result from post-Pleistocene environmental changes, the distributions provide probable rates of evolution. *L. a. seclusus* and *S. l. wortmani* possibly evolved in less than 11,000 years.

Prairie distributions also support the theory of lowered life-zones. Except for the low Central Portal Faunal Area, the Rockies seem to separate numerous closely related pairs (Long, 1965). These, termed east-west pairs, are far more numerous (Table 1) than the north-south pairs (boreal mammals) separated by the Central Portal Area and Upper Green River Faunal Division (Findley and Anderson,

TABLE 1. List of east-west pairs of closely related taxa. The species indicate profound geographic isolation in the past, as do the numerous pairs. The list is updated from the discussion in Long (1965), incorporating recent range extensions.

Interacting as species in Wyoming	Subspecies pairs
1. *Sylvilagus floridanus* *S. nuttallii*	1. *Sorex cinereus haydeni* *S. c. cinereus*
2. *Spermophilus richardsonii* *S. armatus*	2. *Reithrodontomys m. dychei* *R. m. megalotis*
3. *Cynomys leucurus* *C. ludovicianus*	3. *Microtus pennsylvanicus insperatus* *M. p. pullatus*
4. *Perognathus flavescens* *P. fasciatus*	4. *Ondatra zibethicus cinnamominus* *O. z. osoyoosensis*
5. *Spilogale putorius interrupta* *S. p. gracilis*	5. *Erethizon dorsatum bruneri* *E. d. epixanthum*
One species in Wyoming, another westward	6. *Canis latrans latrans* *C. l. lestes*
1. *Vulpes velox* *V. macrotis*	7. *Vulpes vulpes regalis* *V. v. machrourus*
Distinct taxa, possibly acting as good species	8. *Mustela vison letifera* *M. v. energumenos*
1. *Sorex vagrans vagrans* *S. v. obscurus*	9. *Taxidea taxus taxus* *T. t. jeffersonii*
2. *Peromyscus maniculatus nebrascensis* *P. m. artemisiae*	10. *Odocoileus virginianus dacotensis* *O. v. ochrourus*
3. *Clethrionomys gapperi galei* *C. g. brevicaudus*	11. *Bison bison bison* *B. b. athabascae*
Subspecies groups	12. *Ovis canadensis audubonii* *O. c. canadensis*
1. *Eutamias minimus* (large size) *E. minimus* (small)	
2. *Spermophilus tridecemlineatus* (large) *S. tridecemlineatus* (small)	

1956; Long, 1965). The species level of differentiation attained by several of the east-west pairs (including *Spilogale putorius gracilis, S. p. interrupta; Sylvilagus floridanus, S. nuttalii; Perognathus fasciatus, P. flavescens; Spermophilus richardsonii, S. armatus;* and others) suggests their isolation in the past by the lowered life-zones of the glaciated Rocky Mountain chain.

The Little Box Elder Cave is found at the eastern margin of the Rockies and at the western margin of the Great Plains (Fig. 2). The mammalian zoogeogaphy of these plains in nearby Nebraska was discussed by Jones (1964); the major alpine glaciations mentioned above for the Rockies are probably correlative with the late continental glaciations that Jones hypothesized as important in Nebraska.

According to Jones (1964) one needs to look no further back than the Wisconsin glaciation to explain the composition of the Recent mammalian fauna of Nebraska. He considers the Wisconsin advance (18,000 BP) and the Valders readvance (10,000-11,000 BP) as cold, wet periods related to a climate cooler than present. There probably were at that time in Nebraska some biotic assemblages seen today in more northern regions. Dillon (1956) suggested that at

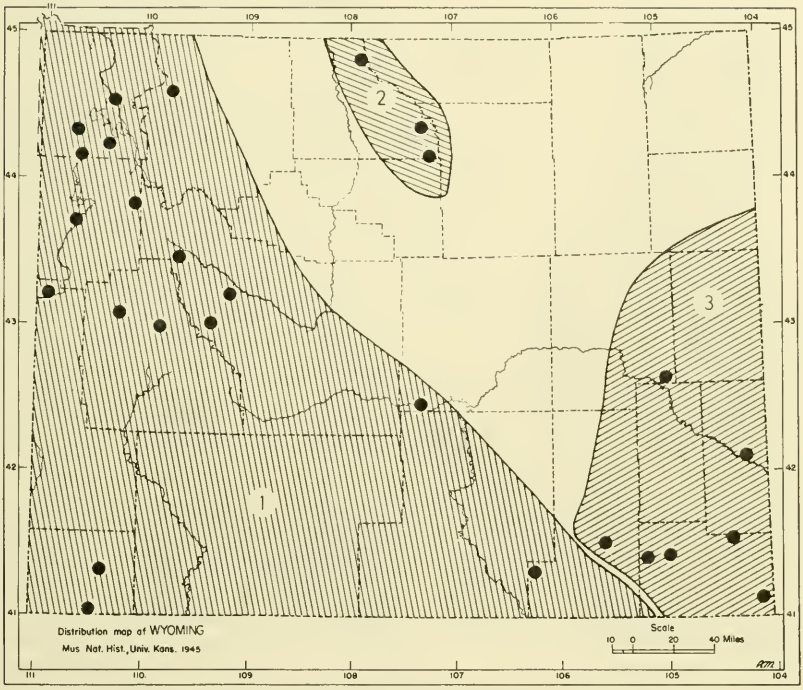

Fig. 3. Distribution of *Lepus americanus* and *L. californicus*: 1, *L. a. bairdii;* 2, *L. a. seclusus;* 3, *L. californicus*. Explanation in text.

the height of the Wisconsin glacial advance the Canadian Life-zone, characterized by conifers and aspen, was the warmest life-zone in Nebraska. Subsequently the climate in Nebraska moderated and warmth-adapted biotas approached the Rockies from the east. Jones (1964) suggested that the climate became so warm (the climatic optimum) after the Valders retreat (following the peak of Wisconsin glaciation) that some mammalian distributions in Nebraska were markedly affected. Populations of the short-tailed shrew, *Blarina brevicauda*, were separated. The pack rat, *Neotoma floridana*, ranged northward to the border of South Dakota, where a relict population now occurs.

Little Box Elder Cave

The entire faunal list of the mammals found so far in the cave and reported by Anderson (1968) need not be repeated here. The fossil remains evidently were deposited from late Wisconsin time to the present, comprising a mixture of boreal and warmth-adapted forms. The assemblage appears diverse; the sample, adequate for interpretation.

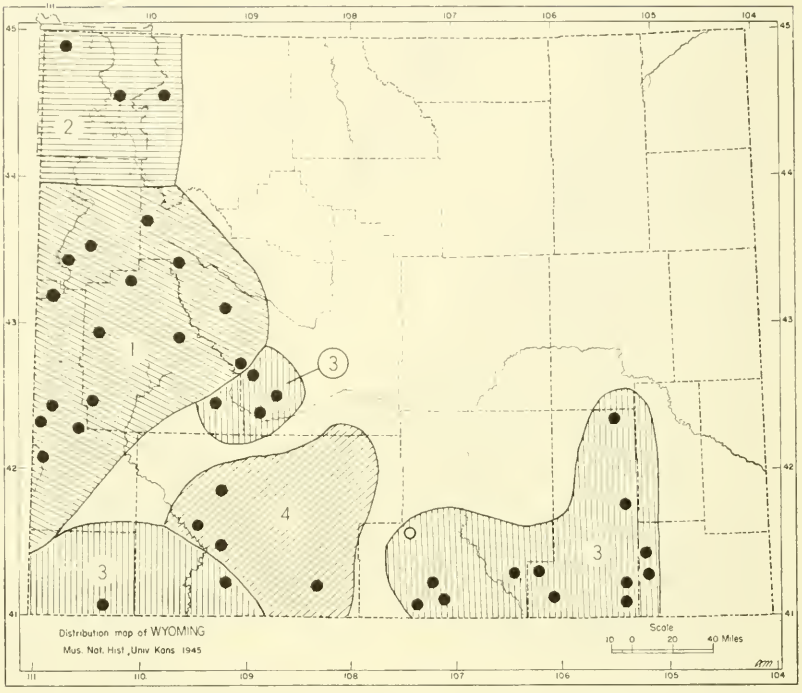

Fig. 4. Distribution of golden-mantled ground squirrels in Wyoming: 1, *Spermophilus lateralis castanurus;* 2, *S. l. cinerascens;* 3, *S. l. lateralis;* 4, *S. l. wortmani.*

Order Insectivora.—Fossil shrews not represented in the Recent fauna (Long, 1965) are *Cryptotis* sp. and *Microsorex hoyi. Cryptotis parva* today occurs along the Platte River as far west as Keith County, Neb. (Jones, 1964), and apparently has withdrawn its geographic range from the Laramie Mountains in eastern Wyoming. This finding certainly substantiates Jones's hypothesis that some species (e.g., *Neotoma*) have retreated since the climatic optimum. *Microsorex hoyi* was found in the northernmost Rockies of northern Colorado by Lechleitner and Pettus (1963), and since then Brown (1966) extended the known geographic range from there into the nearby Snowy Range, which is approximately 150 miles from Little Box Elder Cave (Fig. 2). Spencer and Pettus (1966) found *Microsorex* associated with wet coniferous forests, in a dry-moist microhabitat; its apparent absence from the Laramie Mountains indicates that arid habitats have developed there.

Orders Chiroptera and Primates.—The fossil bats reported from the cave are all found in the same region today (Long, 1965; Jones, 1964; Jones and Genoways, 1967). Bats, being highly mobile, are not so useful as other mammals for studies in zoogeography. The

same is true for man, represented by a single specimen in Little Box Elder Cave.

Order Lagomorpha.—The pika, *Ochotona princeps*, is a valuable fossil from the cave. Pikas are not confined to high or cold habitats as Anderson (1968) and other authors have affirmed. In southwest Wyoming and in other states pikas occur in rock piles, in low (warm) or high (cold) habitats. However, the pika, as well as the shrew *Microsorex*, is absent from the Laramie Mountains today but is present 150 miles southward in the high Snowy Range (Fig. 2).

Order Rodentia.—Some Recent rodents are conspicuously absent from Little Box Elder Cave. The chances of preservation being low for some species may account for their absence (perhaps harvest mice, *Reithrodontomys*), but it is difficult to appreciate why species as common today as the kangaroo rat, *Dipodomys ordii*, and the grasshopper mouse, *Onychomys leucogaster*, are absent in the cave. The jumping mice *Zapus princeps* and *Z. hudsonius* are not reported from the cave but occur near the area today, in moist meadows.

Jones (1964) postulated a distribution for the pack rat, *Neotoma floridana*, ranging through Nebraska to the border of present-day Wyoming in the climatic optimum. The absence of *N. floridana* from Little Box Elder Cave is consistent with his hypothetical distribution.

The heather vole, *Phenacomys longicaudus;* rock squirrel, *Spermophilus variegatus;* and meadow vole, *Microtus pennsylvanicus*, reported from the cave have apparently retreated from the cave area. *S. variegatus* and *M. pennsylvanicus uligocola* are known from northern Colorado, and *Phenacomys* is found in the Snowy Range (Fig. 2). Other subspecies of *M. pennsylvanicus* occur in northern Wyoming.

The fossil lemming *Dicrostonyx* (Anderson, 1968; Guilday, 1968a), probably *D. torquatus*, indicates a formerly cold climate. Today *Dicrostonyx* is found only in the far north.

Order Carnivora.—The fossil canids are found in the same region today, except the wolf, *Canis lupus*, which, in this century, has been extirpated there by man. The fossil *Vulpes vulpes* indicates that the red fox has inhabited the Central Rockies since late Pleistocene. The large size of the fossil fox resembles that of the Recent prairie subspecies *V. v. regalis* more than the smaller *V. v. macroura* which inhabits the Rockies (Long, 1965). The prairie subspecies may have retreated slightly eastward (Goshen County, Sand Hills Division) as did the shrew *Cryptotis*.

The Mustelidae are well represented from Little Box Elder Cave. Most of the fossil musteline species are present today, although the black-footed ferret, *Mustela nigripes*, is exceedingly rare if still present. Hershkovitz (1966) reported a sight record near Casper, Wyo.

The pine marten, *Martes americana*, is another species that possibly retreated southward slightly from the Little Box Elder Cave region. The marten may occur in the Laramie Mountains; it is known from the nearby Snowy Range but not from the Black Hills

or Bighorn Mountains to the north (Fig. 2). The fossil pine marten indicates former coniferous forest at the cave, as do the records of *Microsorex* and *Phenacomys*.

Long (1965) reviewed the status of the wolverine *Gulo gulo* (=*G. luscus*) in Wyoming, where it is known only from the northwestern counties. However, Jones (1964) reported Recent *Gulo* from Scotts Bluff County, in nearby western Nebraska. His record discredits Anderson's hypothesis that *Gulo gulo* retreated northward in Wyoming because of warming temperature.

Anderson's specimen of *Taxidea* is of a huge badger (length of skull, 143.3 mm; zygomatic breadth, 94.4 mm), slightly larger than the largest Recent specimens I have observed. Her specimen is significantly larger than those obtained in modern times from eastern Wyoming. A specimen from Pawnee Creek, Neb., of Pleistocene age, is likewise large (Cook, 1931).

Anderson (1968) was apparently unaware of Long's (1964) new name combination, *Taxidea taxus marylandica*, for a badger from Cumberland Cave, Md. This taxonomic assignment was made because the Maryland specimen (1) differed slightly from specimens of all the Recent subspecies, but (2) was doubtless capable of interbreeding with any of them. Furthermore, the assignment worked a nomenclatural compromise between those taxonomists who emphasized the former condition and those who recognized the latter. Badgers have retreated generally westward from Maryland, New York, and Kentucky since the Pleistocene (Long, 1964; Guilday, 1968b).

Of interest is the apparent absence of the spotted skunk, *Spilogale*. Long (1965) hypothesized that *Spilogale putorius gracilis* and *S. p. interrupta* approached each other interacting as species in eastern Wyoming after the extensive glaciations of the Pleistocene. He reported that specimens of both spotted skunks were taken sympatrically from the same trap at Iron Mountain, in Laramie County, Wyo. Mead (1968) found that these spotted skunks have different reproductive patterns and appear to be isolated reproductively by a temporal mechanism. Jones (1964:29) found all Nebraskan *Spilogale* referable to *interrupta* and hypothesized that it dispersed westward through Nebraska.

The felids in Little Box Elder Cave are found today in this region except that *Panthera atrox* is extinct and the mountain lion, *Felis concolor*, has been drastically reduced in numbers by man.

Orders Perissodactyla and Artiodactyla.—The records of two Pleistocene horses, in Little Box Elder Cave, may indicate a strong prairie influence (in the climatic optimum?). *Camelops* and *Tanupolama* are interesting records of camelids now extinct in North America. Most of the remaining fossil artiodactyls are found in the region today. The mountain sheep, *Ovis canadensis*, has been locally extirpated. However, the mountain goat, *Oreamnos*, is now known only far to the north except for man-made introductions into the Yellowstone area (Long, 1965). The tentatively identified *Symbos*

(p. 18) is now extinct. The questionable specimen of *Alces alces* is interesting because the moose occurs now no closer to the cave than the Wind River Mountains in western Wyoming (Fig. 2).

Past Ecological Requirements.—There are problems in understanding past climatic and other ecological conditions on the basis of such a heterogeneous mixture of boreal and warmth-adapted taxa as found in Little Box Elder Cave. It is not accurate to state that *Dicrostonyx* occurs in cooler habitats than those found in Wyoming today, because the Hudsonian and Arctic-alpine life-zones are widespread, even if narrow, in the Rockies. It is now obvious that some of the fossil forms reported as "boreal" (e.g., *Gulo*, *Phenacomys*, *Eutamias*, *Ochotona*) are not always confined to boreal zones. Finally, the presence of both warmth-adapted and boreal species mixed together (e.g., *Cryptotis* and *Dicrostonyx*) is not easily construed as an ecological succession in which the former replaces the latter. Unfortunately, the remains have not been carbon-dated, but the boreal species reportedly did predominate in the lower strata so far excavated in the cave.

Other evidences (zoogeographical, geological, paleontological) from other places suggest that the cold Wisconsin climate moderated, and that it even became warmer than present. Animal distributions (Long, 1965; Jones, 1964) provide evidences for reconstructing the ecological history of this study region. For example, it is quite reasonable to assume that when the climate was warmer than at present *Cryptotis* might have rapidly expanded its range westward in the narrow riparian habitats along the Platte River as far as Little Box Elder Cave, and subsequent cooler climate may have caused this species to withdraw to its present position. This explanation is the simplest in view of the Recent mammalian distributions and ecological requirements of the mammals.

Summary and Conclusions

Anderson's conclusion (1968:52) and my own (Long, 1965:733) that some coniferous forests occurred in what are now arid lowlands is derived from studies of the fossils in the first case and numerous Recent animal distributions in the second. This conclusion is reinforced by palynological studies from nearby areas (Hansen, 1951; Watts and Wright, 1966). The hypothesized effects of alpine (Long, 1965) and continental glaciations (Jones, 1964) on mammal distributions in the region are supported by Anderson's paleontological findings. The presence of cold-adapted species such as *Dicrostonyx* and *Oreamnos* indicate that the climate was formerly colder (also indicated by geomorphic studies on alpine and continental glaciations). Anderson suggested that these boreal mammals and others have retreated northward as the climate warmed, and a relict Recent population of *Lepus americanus* from the Bighorn Mountains suggests the same thing.

The presence of several fossil species substantiates Jones's (1964) hypothesis that some mammals on the Great Plains were affected

by the climatic optimum. Some mammals have retreated southward and eastward since this very warm period. The withdrawal of several boreal taxa from the cave area apparently resulted from an abrupt amelioration of cold climate. Several lowland mammals (e.g., *Cryptotis*, *Spermophilus variegatus*) apparently overextended their boundaries for the climate of Recent time and were extirpated in the Laramie Mountains.

The fossil remains in the Little Box Elder Cave not only substantiate to some extent several zoogeographical hypotheses about Wyoming and Nebraskan mammals, but also provide important evidence which, when used with zoogeographical evidence, suggests that at least along the eastern margin of the Rocky Mountains the warm climatic optimum altered and influenced the distribution of some Rocky Mountain mammals.

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I wish to thank Professors Philip Bjork and J. Knox Jones, Jr., for their advice concerning this paper.

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LIMNOLOGICAL STATUS OF BIG SODA LAKE, NEVADA, OCTOBER 1970

Ervon R. Koenig[1], John R. Baker[1], Larry J. Paulson[1], and Richard W. Tew[1]

Abstract.—On 17 October 1970, the thermocline in the mixolimnion of Big Soda Lake, Nev., was located between 15 and 20 m below the surface. The chemocline was found to lie between 30 and 35 m depth. Significant dilution of the lake has occurred since 23 July 1933.

Introduction

Big Soda Lake, near Fallon, Nev., is of interest because it is meromictic and because the mixolimnion is thermally stratified. This post-Lahontan crater lake was last analyzed in detail by G. E. Hutchinson on 23 July 1933 (Hutchinson, 1937), who noted the ectogenic origin of meromixis as a result of regional irrigation and predicted that dilution by ground water would eventually abolish chemical stratification altogether at a rate of 1570 metric tons chloride per year. Sufficient time has passed since Hutchinson collected his data to reinvestigate the characteristics of the lake and to check on the fate of chemical stratification.

Methods[2]

Samples were collected and temperatures determined by the use of Dussart bottles (Golterman, 1969). Chemical analyses were performed according to Standard Methods for the Examination of Water and Wastewater (American Public Health Association, 1960). The chloride data in Table 1 are the averages of single mercuric nitrate assays performed by two groups of analysts. Salinities were determined with a Hach #2200 meter and are reported as the specific conductance noted for the *stated dilution of sample.* Sulfides were determined colorimetrically.

Results

The data in Table 1 indicate that on 17 October 1970 Big Soda Lake was stratified chemically between 30 and 35 m and thermally in the mixolimnion between 15 and 20 m. The deepest point noted in a transect of the lake was 65 m, indicating no significant change in level since 1933.

The temperatures recorded for the October 1970 monimolimnion and the mixolimnion below the thermocline correlate closely with Hutchinson's (1937) data for these regions of the lake in July 1933.

Comparison of data for October 1970 and 23 July 1933 (Hutchinson, 1937) indicates that significant dilution has occurred and that

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[2]Confirmation of sulfide data by Mr. James H. Parrott, manager, and Mr. Sam Shannon, analyst, Clark County Sanitation District No. 1, is gratefully acknowledged.

TABLE 1. Analyses of Big Soda Lake, 17 October 1970.
Hutchinson's (1937) data for 23 July 1933 are in parentheses.

Depth, m		Temperature, C		Chloride, ppm		Sulfides, ppm		Specific Conductance Dilution	umho/cm	Visual Color
0	(0)	16.5	(24.75)	6783±33	(8200)	0	(0)	10	4200	Clear
5	(5)	16.5	(23.03)	6985±210		0		10	4200	Clear
	(7)		(17.82)							
	(10)		(11.82)		(8200)		(0)			
15		16.5		6795±10		0		10	4200	Clear
20	(20)	9.0	(8.94)	6200±5	(15100)	0	(456)	10	4200	Pink
25		9.5		6732±33		0		10	4200	Pink
30		8.2		6980±95		3		10	4500	Light Yellow
35		12.0		18175±700		400		25	4350	
	(40)		(12.60)		(27300)		(456)			Yellow
45		12.5		25650±338		300		25	5670	Yellow
	(60)		(12.60)		(27300)		(786)			
65		12.5		23412±462				25	5300	Yellow

On 17 October 1970, the 55 m temperature was 12.5. The sample was subsequently lost.

a more sharply defined chemocline now exists at a considerably deeper level. The datum of 7520 ppm chloride recorded for surface waters in 1958 (Whitehead and Feth, 1961) partially substantiates the evidence for continuing dilution over the past 27 years.

Sulfides were not found below the thermocline in the mixolimnion. The purple sulfur bacteria ("bacterial plate") noted in this region may be expected to convert sulfides leaking through the chemocline to sulfate as long as the mixolimnion is stratified and the "hypolimnion" anaerobic. Thus, net loss of gaseous hydorgen sulfide from the lake, as noted by Borchert and Muir (1964) for marine sediments, may occur only during the period of mixolimnion circulation. Thus, it is not surprising that the sulfides present in the central monimolimnion were not dramatically lower than values recorded for 1933. However, Hutchinson's value of 786 ppm sulfide at 60 m is more difficult to reconcile with our finding of 300 ppm at 65 m but may represent discrepancies in the actual points of sampling. Our sampling regime may have missed a localized area of high sulfide concentration located by Hutchinson.

Actually, since 700 ppm sulfate were noted in the central monimolimnion in October 1970, considerable potential for additional sulfide production exists, and the discrepancy in the data for sulfides near the sediment-monimolimnion interface may also reflect reduced amounts of hydrogen sources sinking through the monimolimnion from the mixolimnion and becoming available for sulfate reduction. Obviously needed are additional studies correlating (1) the migration of sulfate to the sediment surface, (2) concommitant addition to the monimolimnion and sediments of hydrogen sources from the mixolimnion, and (3) the actual count of sulfate reducing bacteria throughout this region of the lake.

Identification of plankton was not attempted except for the organisms in the bacterial plate, which consisted mainly of *Rhodothece* and *Thiothece* (Breed, et al., 1957; Pfennig, 1967).

The technical contributions of Scott Miller and Mary S. Baker are gratefully acknowledged.

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BREEDING BEHAVIOR OF THE BOREAL TOAD, *BUFO BOREAS BOREAS* (BAIRD AND GIRARD), IN WESTERN MONTANA

Jeffrey Howard Black[1] and Royal Bruce Brunson[2]

The boreal toad, *Bufo boreas boreas*, is the most frequently observed toad in western Montana and other parts of the Pacific Northwest. Yet little is known of the breeding behavior of this subspecies. The purpose of this paper is to discuss the breeding behavior of the boreal toad as observed in western Montana during 1966 and 1967.

Nine ponds and their breeding populations of the boreal toad were observed during the springs of 1966 and 1967. Three temporary pools filled by underground seepage from the Clark Fork River, 7.7 miles northwest of Missoula, and two spring overflow ponds in the Clark Fork River flood plain 6.7 miles northwest of Missoula, Missoula Co., were observed in both years. Two large ponds 1 miles north of Victor, and two water-filled gravel pits 8 miles southeast of Hamilton along Skalaho Highway 38, Ravalli Co., were observed during the spring of 1967. Practically all breeding sites were dry until the spring runoff.

Results

The two gravel pit ponds 8 miles southeast of Hamilton along Skalaho Highway 38 contained the largest populations of breeding toads and their behavior was typical of that observed at other ponds in western Montana. The two gravel pits are about 100 ft apart and one-half acre in size when filled with water (Fig. 1). Vegetation was limited to areas of cattails (*Typha* sp.). Water was clear and 5 ft deep at the middle.

On 11 May 1967, only a few males were present on the shores or hiding in the dry cattails. By 14 May, each pond contained at least 30 waiting males. Most males were in the cattails with only their eyes and front legs above the water surface, while others were in the shallow water near shore with their anterior halves resting on rocks (Fig. 2). All males were spaced at intervals along a single shore and not around the whole pond. There was at least one foot of distance between each male, and all were facing the shore.

Males from one pond were collected and released on the shore of the adjacent pond. As soon as the movement of the new arrivals was noted, the waiting males swam to them and clasping attempts were made with "protest" chirps coming from the clasped male. Males did not stay clasped for any length of time; however, the wrestling of one pair of males attracted all the others until the water was boiling with wrestling males. If a male was clasped behind the forelegs, a "protest" chirping was immediate. This protest chirping attracted other males toward the sound even if the chirping male was on shore and no movements were made. After a few minutes,

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Fig. 1. Pond used for breeding by the boreal toad 8 miles southeast of Hamilton, Ravalli Co., Mont.

the males would start moving apart and again space themselves from each other along the shore. Individual males would frequently give protestlike chirps. On 16 May, at least 40 males were present in each pond and the first pair in amplexus was found in a quiet, hidden area. Eggs had not yet been laid in the ponds. The anal temperature of the waiting males ranged from 17.6 to 18.1 C in water which was 17.6 C. Recorded protest calls from the Victor ponds were brought to these ponds on 18 May. From the nearby highway, the water appeared to be boiling and the protest chirping chorus was loud. This slow chirping chorus could be heard for some distance. Two sets of eggs had been laid, and one pair in amplexus was hidden in the dense grass along shore. The taped calls were played on the shore which attracted some males and clasping attempts were made. Movements of a net or hand in the water with or without the recorded calls attracted numerous males, and at one time 31 males were around the moving aquatic net in the water. The pair in amplexus was taken from their hiding place in the grass and placed in the open water. The pair was immediately attacked by 6 males which the male in amplexus kicked away with his hind legs; the mated pair returned to their hiding place where they were not bothered by the other males.

Fig. 2. Male boreal toad in the breeding pond 8 miles southeast of Hamilton. Typical waiting position of the male in shallow water along shore.

The ponds were visited at night on 18 May, with the recorded protest chirps. At night the males were extremely hard to find; most were floating in the deeper water and only a few were close to shore. The recorded protest calls did attract several males; however, few attempts at clasping were noted. It appeared that practically all breeding activities ceased at night. Even though water temperatures were not taken at night, they were not much lower than the daytime temperatures.

Observations at the breeding ponds in Missoula County and the other ponds in Ravalli County showed similar breeding behavior. Males arrived in early April, and breeding lasted until July, with most breeding activity occurring in May.

Seven males were discovered in a temporary pool on the Clark Fork River on 5 May 1966, when their calling was heard about one-fourth mile away. Males were separated from each other by at least one foot and were along the edge of the pond in clumps of grass, beside logs, or with their front feet on the shore. When approached they ceased calling and swam to the bottom of the pond and remained motionless for a short time, then returned to their calling and watching stations. Their chorus sounded identical to that described above from the breeding sites near Hamilton.

Males in the ponds north of Victor were very bold and also came toward any movement in the water. Individual males were observed giving the protest chirps from stations in clumps of *Typha*, and wrestling groups of male were common.

Discussion

The breeding behavior of the boreal toad in Montana was similar in many respects to that reported for other *Bufo* and *B. b. boreas* in other localities. Males greatly outnumbered the females at all breeding sites in Montana and started arriving about five days before the females and spaced themselves along the pond's edge. All males faced in the same direction, usually toward a gently sloping shore.

Karlstrom (1962) reported that male *B. canorus* were in a highly excited state during the height of their chorus at midday and early afternoon. Competition for the few females was intense. *B. b. boreas* males in Montana were also in a highly excited state during the day; however, breeding activity all but ceased at night. There was also intense competition among males for the females, and this was probably the cause of toads in amplexus being hidden and secretive during the day when the height of the male breeding activity existed. Any movement on the shore or at the edge of the water stimulated all males to move toward it, and attempts to clasp other males or dislodge a male in amplexus with a female were common.

Males of the *B. boreas* group lack an enlarged resonating vocal pouch; therefore, the voice is weakly developed. The call of *B. boreas* is a soft chuckle or a birdlike chirp according to Pickwell (1947), Wright and Wright (1949), and Stebbins (1951). Baxter (1952) described the call of *B. boreas* in southeastern Wyoming as a short chirp, repeated at regular intervals. Notes from individual toads were similar to the warning chirps uttered by the male when clasped, jostled by other toads or when handled. Karlstrom (1962) described the weakly developed call of *B. boreas* as consisting of short chirps, five to ten rapidly developed notes in a series. Mullally (1956) reported that male *B. boreas* vocalized only when other males grasped them as if to assume the position of amplexus. Most authors imply that separate and untouched males do not call or form breeding congresses.

Calls of male *B. b. boreas* at the Hamilton and Victor breeding ponds were recorded during 1967. Audiospectograms of these were made in 1969 by Dr. Kenneth R. Porter, University of Denver. He reported that the calls recorded were "protest" or "release" calls which had been described by Karlstrom (1962). Porter suggested that these calls should not be confused with true mating calls and that their function in attracting other males and/or females is doubtful, but should be tested.

In Montana such calls were most frequently emitted by males when they were clasped by another male and hence were true "release" or "protest" calls. However, at the breeding ponds along the Clark Fork River and at the Victor and Hamilton sites, calls were

being given by single males in an excited state which were not being amplexed by other males. These calls could be heard one-fourth mile away. Recorded protest calls also attracted other males. These observations in Montana indicate that slow chirps uttered by males when clasped or by individual males do serve as an attractant for other males and probably also for attracting females to the breeding sites and the waiting males.

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NOTES ON WHITE-TAILED PRAIRIE DOG (*CYNOMYS LEUCURUS*) BURROWS

Tim W. Clark[1]

White-tailed prairie dogs are able to withstand only a portion of the total range of environmental conditions that prevail annually on the surface of the ground. The burrow environment makes existence possible during periods of unfavorable conditions at the ground surface. The burrow serves for temporary refuge from predators, from excessive summer temperatures or for total withdrawal for several months during the long periods of winter until favorable conditions above ground permit activity there once again.

Some aspects of the burrow systems of black-tailed and Gunnison's prairie dogs have been investigated. However, published information is totally lacking on burrows of the other three species of North American prairie dogs (white-tail, Utah, and Mexican prairie dogs). As part of a study of the ecology and ethology of the white-tailed prairie dog in the Laramie Basin of Wyoming (Clark, 1969) some data was gathered on burrows. This paper presents this information.

Study Area and Methods

Burrows were investigated on eight colonies of white-tailed prairie dogs located on or near Hutton Lake National Wildlife Refuge, Albany County, Wyo. The refuge is situated in southeastern Wyoming, 12 miles southwest of Laramie and 10 miles north of the Wyoming-Colorado border. This area is in the Laramie Plains (elevation 7200 ft) and falls within what Cary (1917) called "Transitional Life-Zone" and Porter (1962) termed "Interior Grassland Plains." This area has been described in detail by Clark (1969). Burrow excavations were carried out on the refuge in the fall of 1966, and observations on other aspects of burrows were made in the summers of 1967 and 1968.

Mapping.—A grid was established on one colony by driving colored stakes (4 ft tall) into the ground at 100 ft intervals. The

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resulting grid was characterized by 19 columns, lettered A through S, each column consisting of nine rows, numbered 1 through 9. The grid was 1800 ft long and 800 ft wide.

All of the burrow openings in the grid were marked using numbered metal cattle tags on the end of a 14-inch piece of heavy guage wire. The tags were placed adjacent to each opening; thus each hole had an individual designation. A total of 827 burrows were marked. An estimated 100 burrows were outside of the grid and only about 25 of these were marked and mapped.

The spatial arrangement of the burrow openings within the grid were mapped using grid stakes for orientation. Each opening was characterized with respect to its features (e.g., mound type, diameter of entrance, etc.).

Burrows.—One burrow and part of another were excavated and their structure studied. A one-fourth inch diameter plumber's auger 9 ft long was used to probe ahead of the excavation and prevented loose dirt from falling down into the tunnel. This same piece of equipment served to plug up the tunnel behind temperature and relative humidity measurements.

Microclimatic measurements of the burrow were taken using a hand aspirated psychrometer and a clock-dial-type soil thermometer. A set of microclimatic measurements were taken every 3 ft of tunnel. Each set of measurements consisted of air temperatures, relative humidity values, and soil temperatures.

Organisms other than prairie dogs inhabitating the burrow were sampled by scraping the burrow walls with a small can to remove about 2 inches of soil. The length of each sample was about 3 ft of tunnel. The soil samples were immediately placed in plastic bags and labeled. In the laboratory the soil samples were placed in Berlese funnels for 24 hours. Excelsior was placed in the neck of the funnel to prevent dirt from falling into the collection container. Specimens were preserved in 70% ethyl alcohol.

Results and Discussion

Burrow Mounds.—One of the most obvious indicators of the presence of prairie dogs in an area is the mounds of earth around the burrow entrances. Mounds are formed as a result of the excavation of new burrow systems and the modification of the old ones.

Of the 827 burrows within the grid, 821 conformed to "a mere pile of soil" as described by King (1955) and more specifically followed the description of Tileston and Lechleitner (1966). Only six burrow entrances lacked any type of mound. Those burrow openings without mounds may have resulted from the degeneration of old, unattended mounds or could have been a burrow with little or no excavated soil originally about the entrance. Two of the six burrow entrances lacking a mound seemed to be of the latter type. Since these two entrances were opened by prairie dogs during the course of this study their time of origin was precisely known. The reason

for the lack of dirt around the other four entrances was not determined.

Twelve new burrows were constructed in 1966 and 1967. Nine of these were dug outside of the grid in the fall by dispersing individuals, and all burrows had mounds.

Typically the burrow mound of the white-tailed prairie dog is a large, unconsolidated, semirounded structure composed of excavated subsoil. This type of mound contrasts with mounds of *C. gunnisoni gunnisoni*, which are seldom large (Longhurst, 1944), and those of *C. ludovicanus*, which many times are constructed of excavated subsoil combined with soil around the burrow entrance (Merriam, 1901).

Of approximately 2000 burrow mounds examined in eight different colonies, not one "crater-like" (King, 1955) mound was found nor were white-tailed prairie dogs ever observed or evidence found indicating that these animals shaped, packed, or worked the excavated subsoil of burrow mounds as is characteristic of the black-tailed prairie dog (Merriam, 1901; Scheffer, 1947; Wilcomb, 1954; King, 1955; and Smith, 1958).

Burrow maintenance was generally confined to the spring (March and April) and consisted of removal of materials that had been collected in the burrow entrance during the winter. A similar pattern of burrow maintenance has been reported for white-tailed prairie dogs in northern Colorado by Tileston and Lechleitner (1966).

Spatial Arrangement of Burrows.—The density of burrow openings varied from 22 per quadrat (10,000 sq ft) to 0 per quadrat. The mean number of burrow entrances per quadrat was 5.1 (23.9 per acre). The density of burrow openings varied between vegetation types. Only quadrats lying completely within each vegetation type were used to calculate densities. Burrow entrances in the *Bouteloua-Opuntia* Vegetation Type exhibited a density of 23.2 per acre, the *Agropyron-Oryzopsis* Vegetation Type 23.1 per acre, and the *Sarcobatus* Vegetation Type 13.1 per acre.

Tileston and Lechleitner (1966) found a density of 21.9 burrow entrances per acre for white-tailed prairie dogs and 41.9 per acre for black-tailed prairie dogs in northern Colorado. Bailey (1926) estimated the density of holes to be 20 to 40 per acre in many black-tailed prairie dog towns in North Dakota. King (1955) found 22 holes per acre in Wind Cave National Park and at Devil's Tower, Wyo., and Koford (1958) found 100 per acre where animals were fed by tourists.

Burrow Structure.—The structure of burrows was not extensively investigated in this study. One burrow was totally excavated and another one partially excavated.

Excavation of burrow No. 1 was begun on 13 October 1966. This burrow was located in a peripheral position in another colony near colony No. 1 (Figs. 1 and 2). The entrance mound was 5½ ft in

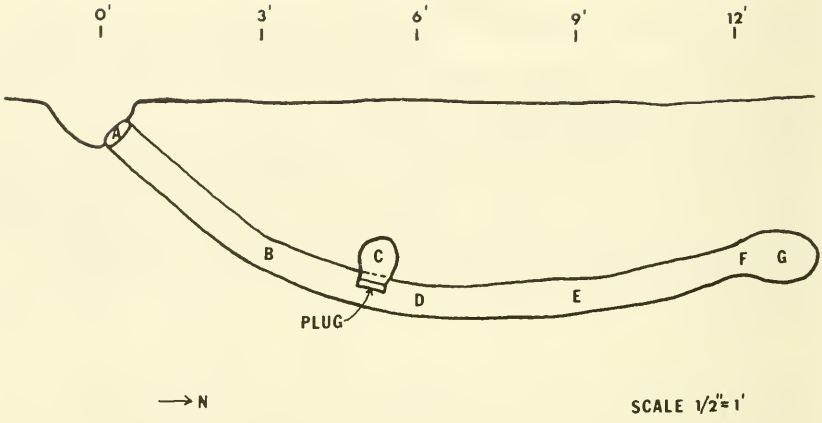

Fig. 1. Schematic diagram showing the side view of white-tailed prairie dog tunnel number one.

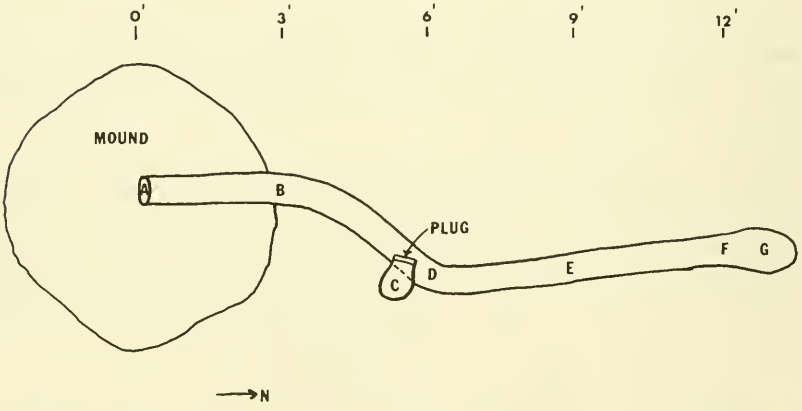

Fig. 2. Schematic diagram showing the top view of white-tailed prairie dog tunnel number one.

diameter and about 6 inches deep. This mound contained three entrances. One entrance was chosen for excavation. The tunnel angled downward at about 40 degrees from the horizontal for the first 7 ft and then it rose about 3 inches per foot to the end. The entrance (station A) was 7 inches in diameter. At station B the tunnel depth was 2 ft, 6 inches, and the diameter of the tunnel was 7 inches. Station C was a blind outpocketing whose entrance had been plugged with dirt. This cavity contained no loose soil or nest materials. It measured 8 inches in diameter and 10 inches in depth. The function of this small outpocketing (C) is unknown. Station D in the tunnel was 3 ft, 8 inches deep, while station E was 3 ft, 6 inches deep and

station F was 2 ft, 11 inches deep. The burrow reached its greatest depth at about 7 to 8 ft from the entrance. The entire tunnel was 12 ft long. At the end of the tunnel was a cavity 18 inches across and 11 inches deep. This cavity showed no signs of ever having been used as a nest chamber. The floor of the gallery was covered with loose soil, which did not exceed 2 inches in depth. The loose soil of the first two stations was mixed with prairie dog feces and recently cut plant matter. No fresh soil or signs of fresh digging were found in the tunnel. The diameter was approximately 7 inches throughout the entire length of the tunnel. No nest materials or prairie dogs were found.

The soil profile was 20-36 inches deep with 40% clay present. A hard clay layer was found 18 inches beneath the surface. The parent material is derived from a shale formation. Excavation on burrow No. 2 was begun on 12 November 1966. This burrow was located about 100 yards west of burrow No. 1 (Figs. 3 and 4). A small mound 2 ft in diameter and 6 inches deep was situated on the west side of the entrance. The first 5½ ft of tunnel dropped at approximately a 45 degree angle from the horizontal to a depth of about 6 ft (stations A, B, and C). The diameter of the entrance (station A) was 7 inches, at station B the tunnel was 2½ ft deep and had a diameter of 7 inches. At a point 7½ ft from the entrance (station C) the tunnel diverged. One branch (Branch No. 1) doubled back under the first 7½ ft of tunnel, the other branch (Branch No. 2) continued on in a level plane in the same direction as the first 7½ ft of tunnel. Branch No. 1, for the first 3 ft, remained

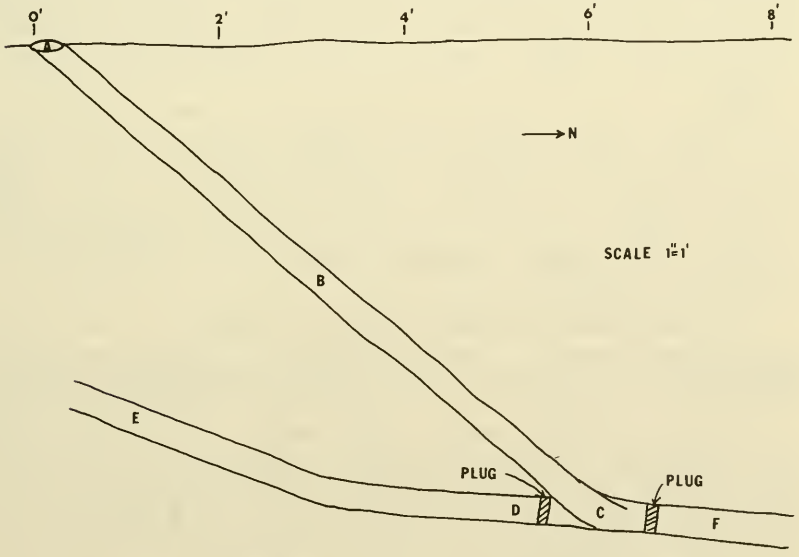

Fig. 3. Schematic diagram showing the side view of white-tailed prairie dog tunnel number two.

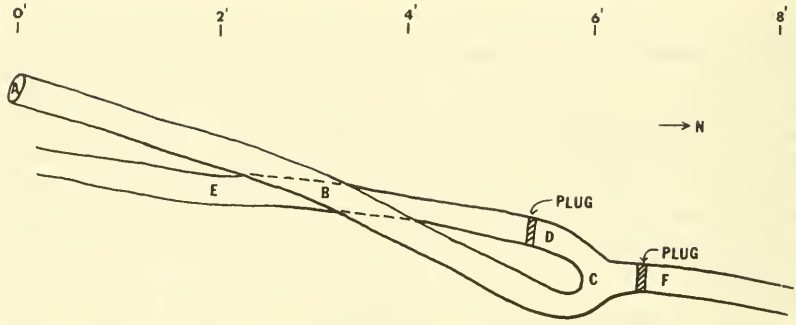

Fig. 4. Schematic diagram showing the top view of white-tailed prairie dog tunnel number two.

at 5½ ft depth and then for the next 2 ft rose to a depth of 4 ft. The entire branch was about 7 inches in diameter throughout its length. Both tunnel branches were plugged with prairie dog feces within 6 inches after the tunnel diverged. The burrow was observed to have been occupied by a prairie dog just prior to the excavation. It was believed that a prairie dog was hibernating in the burrow, since an animal was observed in close association with this burrow up to the time the entire colony had gone into hibernation. Branch No. 2 sloped down over the next 6 ft, dropping over all about 1 ft. The branch had a diameter of 7 inches. About 6 inches beyond the feces plug in this branch a prairie dog femur was found. The floor of the tunnel system was covered by approximately 2 inches of loose dirt. Some plant parts were found near the entrance in the first few feet of the tunnel. At this point, excavation of this burrow was discontinued.

Neither of these burrows was similar to the well-known *C. ludovicanus* burrow excavated by Osgood (Merriam, 1901). Comparing the burrows examined in this study with those of *C. ludovicanus* described by Merriam (1901), Whitehead (1927), Jilson (1871), Thorp (1944), Wilcomb (1954), King (1955), and Smith (1958), and burrows of *C. gunnisoni gunnisoni* investigated by Foster (1955) and Longhurst (1944), there appears to be no species specific pattern of burrow tunnel excavation.

Rongstad (1965) described three types of burrows in the thirteen-lined ground squirrel: nesting, hiding, and hibernating burrows. Observations by McCarley (1966) on *S. tridecemlineatus* and Bradley (1965) on *S. leucurus* agree with Rongstad (1965). This system of burrow classification may be useful in describing prairie dog burrow complexes. Possibly burrow No. 1, excavated in this study, was of the hiding type and burrow No. 2 a hibernating type since it was plugged with feces. The burrows of the white-tailed prairie dog need further investigation.

Burrow Microclimate.—The air temperatures and relative humidity values were investigated in excavated tunnel No. 1. Figure 5

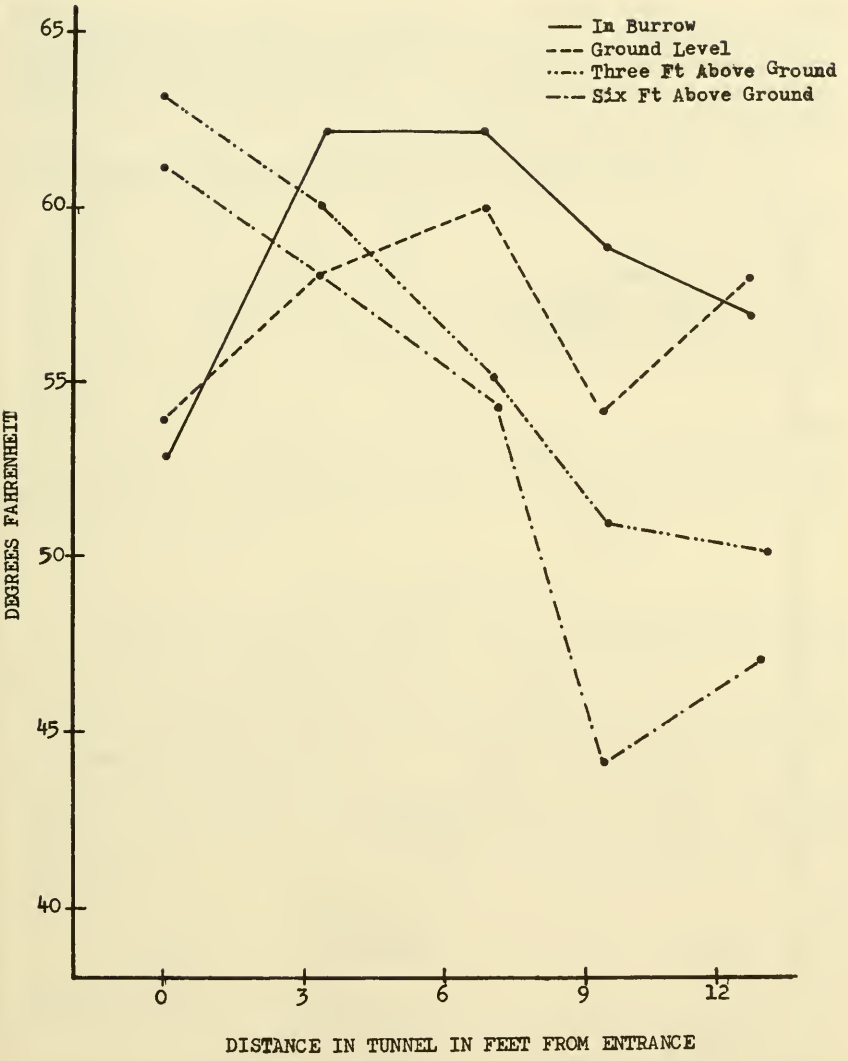

Fig. 5. Air temperatures in degrees F taken at 3 ft intervals within tunnel number one compared with temperatures taken at ground level, 3 ft, and 6 ft above ground surface.

gives the air temperatures in degrees F taken 3 ft ahead of the excavation compared with air temperatures taken at ground level, 3 ft, and 6 ft above the ground surface. The temperature range within the tunnel varied less than the other temperature measurements. The temperature range within the tunnel was 6 F; while at ground level 7 F; 3 ft above ground surface, 14 F; and a 15 F variation at 6 ft

above the ground surface. The first 6 ft of tunnel were excavated one day and the last 6 ft in the following two days. The first 6 ft of tunnel had a constant air temperature of 62 F, while the air temperature of the last 6 ft varied 2 degrees. This may be due to the effects of excavating the first 6 ft. Generally the tunnel was warmer than the other temperatures recorded.

Figure 6 presents the relative humidity in percent taken at 3 ft intervals with tunnel No. 1 compared with relative humidity in

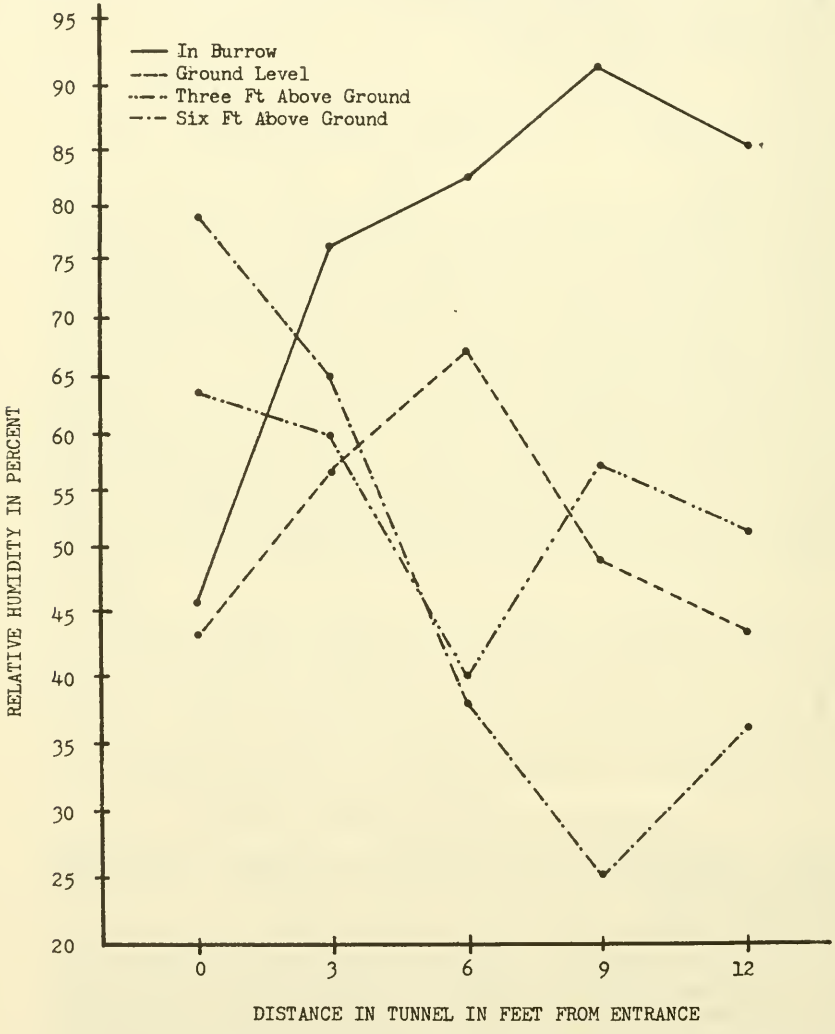

Fig. 6. Relative humidity in per cent taken at 3 ft intervals within tunnel number one compared with relative humidities taken at ground level, 3 ft, and 6 ft above ground surface.

per cent taken at ground level, 3 ft and 6 ft intervals above the ground. The relative humidity in the burrow was higher and more constant than the other humidity measurements. The relative humidity in the tunnel varied 16%; while ground level varied 24%; 3 ft above ground, 24%; and 6 ft above the ground surface, 53%. To what degree the excavational procedures altered the normal air temperatures and relative humidities was not determined.

Organisms in Burrow.—Only burrow No. 1 was investigated for organisms other than prairie dogs. The tunnel contained a number of Arthropods and a few vertebrates. Table 1 presents the identification and the distribution of the organisms found while excavating burrow No. 1. Sample No. 1 (the first 3 ft of the tunnel) contained no organisms. The tunnel walls of sample No. 2 were very dry and rocklike. The tunnel walls in the other samples were composed of loosely packed, moist dirt.

A total of 23 specimens was found. Sample No. 3 contained the largest number of individuals (N=12), while sample No. 4 contained the greatest taxonomic diversity. The only vertebrates were found in the enlarged terminal segment of the tunnel.

Acknowledgments

I would like to acknowledge Dr. L. N. Brown whose NSF grant supported the major portion of this study.

Table 1. Identification and Distribution of the Organisms by Sample Found in Tunnel Number One.

Sample	Organisms	Numbers
Number 1	————	————
Number 2	Coleoptera	
	Scrabaeidae	
	Coprinae	1 adult
	Tenebrionidae	1 adult
Number 3	Diptera	
	Psychodidae	1 adult and 1 larva
	Sarcophagidae	10 adults
Number 4	Orthoptera	
	Gryllacrididae	
	Rhaphidophorinae	1 adult
	Coleoptera	
	Tenebrionidae	2 adults and 2 larvae
	Scarabaeidae	1 larva
	Tiger Salamander:	
	Ambystoma tigrinum vavortum	1 adult
	Cricket Frog:	
	Pseudacris nigrata triseriata	2 adults

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THE ALGAE OF UTAH LAKE. PART II.

William J. Harding[1]

This paper is the second in a series to update and to contribute to the known algal flora of the state of Utah as well as Utah Lake. Included here are 17 new records for Utah, and 3 other species which have not been previously reported from Utah Lake. It is hoped that the contributions made within these reports will be the starting point to other related investigations.

I wish to thank in addition to those previously mentioned (Harding, 1970) Drs. D. A. White and V. M. Tanner, Department of Zoology, and Drs. S. L. Welsh and W. D. Tidwell, Department of Botany and Range Science, Brigham Young University, Provo, Utah, for their encouragement and guidance. This study is one of many being conducted through the Utah Lake Research Station, Brigham Young University, Provo, Utah.

Cyanophyta

Anabaena oscillarioides Bory

Fig. 6

Filaments straight, entangled or solitary. Cells barrel-shaped or truncate-globose, 4-6 μ in diameter, 7-8 μ long. Heterocysts round or ovate; 6-8 μ in diameter, 6-10 μ long. Gonidia cylindrical; developing on both sides of heterocyst (rarely on one side only) or in a series; 8-20 μ in diameter, 20-40 μ long. Forming thin films on detritus, or subaerial in swampy places along the margin of the lake and in backwater pools.

Chroococcus minor (Kuetz.) Naegeli

Fig. 2

A small gelatinous attached and amorphous mass in which cells are irregularly scattered, singly, in pairs, or in larger groups. Cells are spherical or angular from mutual compression and the contents nongranular, pale to bright blue-green; individual sheaths scarcely visible, confluent with the colonial envelope; cells 3-4 μ in diameter without sheath. Found intermingled with dense clots of miscellaneous algae; sometimes buried in the decaying tissues of higher plants. New record for Utah.

Chroococcus minutus (Kuetz.) Naegeli

Fig. 3

A small, amorphous, mucilaginous mass in which spherical or hemispherical cells are compactly arranged within a wide hyaline

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envelope; individual cell sheaths indistinct, not laminated; cell contents blue-green, either finely granular or homogeneous; cells 4-10 μ in diameter without sheaths. Found around dense algal growths in shallow-water and isolated ponds and in swamps. New record for Utah.

Chroococcus turgidus (Kuetz.) Naegeli

Fig. 4

A free-floating colony of 2-4 ovoid cells enclosed by wide, hyaline, and lamellate colonial sheath; cells bright blue-green, contents granular, enclosed by individual sheaths, 8-32 μ in diameter without sheath, 15-50 μ wide with sheath. Found in same habitat with *C. minutus*.

Coelosphaerium dubium Grunow

Fig. 7

Plant a spherical or irregularly shaped colony of spherical cells, or an aggregate of colonies in a common gelatinous envelope; free-floating; cell arranged to form a peripheral layer with the colonial mucilage, producing a hollow sphere; cell contents blue-green, either homogeneous or with pseudovacuoles; cells 8-10 μ in diameter. Rare in euplankton. New record for Utah.

Lyngbya major Meneghini

Fig. 9

Plants solitary among other algae; filaments straight; trichomes not or very slightly tapering to the apices, which are capitate, 11-17 μ in diameter; cells 4-5 times wider than long, 2-4 μ in length, not constricted at the crosswalls, which are granulose; cell contents homogeneously granular; sheaths thick (3-3.7 μ), firm, and usually laminated; filaments 22-26 μ in diameter. Tychoplanktonic and in shallow backwater ponds.

Marssoniella elegans Lemm.

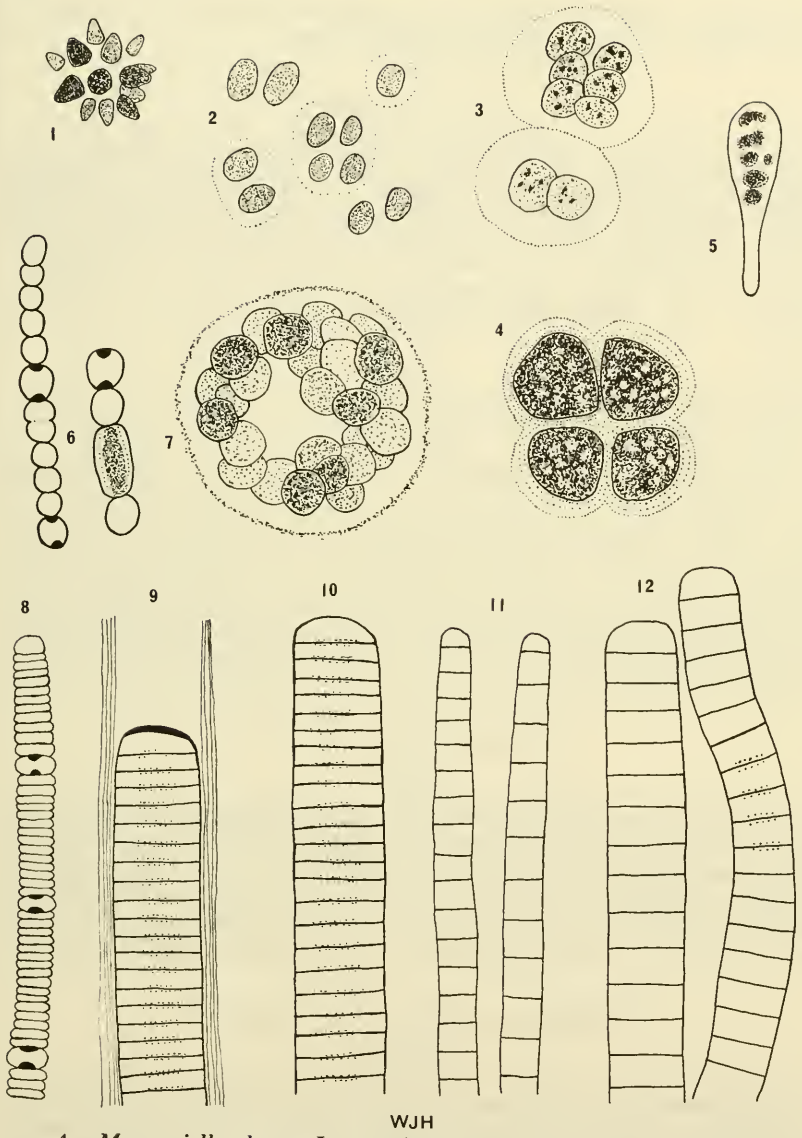
Fig. 1

A colony of 8-12 ovoid or pyriform cells, radiately arranged, with their narrow ends directed outward, enclosed by a thin, transparent sheath; cells 1.5-5 μ in diameter, 5-6 μ long. Rare in euplankton. New record for Utah.

Nodularia Harveyana (Thu.) Thuret

Fig. 8

Filaments usually solitary; nearly straight, not entangled. Sheaths colorless and thin, usually diffluent and becoming indistinct. Cells 4-6 μ in diameter, length $\frac{1}{3}$ the diameter. Apical cell obtusely coni-



WJH

1. *Marssoniella elegans* Lemm. 800X
2. *Chroococcus minor* (Kuetz.) Naegeli 1000X
3. *C. minutus* (Kuetz.) Naegeli 1000X
4. *C. turgidus* (Kuetz.) Naegeli 400X
5. *Characiopsis cylindrica* (Lambert) Lemm. 700X
6. *Anabaena oscillarioides* Bory 800X
7. *Coelosphaerium dubium* Gron. in Raben. 600X
8. *Nodularia Harveyana* (Thu.) Thuret 1000X
9. *Lyngbya major* Menghini 750X
10. *Oscillatoria limosa* (Roth) C. A. Agardh 750X
11. *O. tenuis* C. A. Agardh 800X
12. *O. nigra* Voucher 1100X

cal. Gonidia nearly spherical or compressed-spheroidal; about 8 μ in diameter. Tychoplankton in shallow water.

Oscillatoria bornetii Zukal

Trichomes forming a slimy, expanded plant mass, or intermingled among other algae; more or less straight but often bent or slightly sigmoid in the apical region, not tapering toward the apex. Apical cell smoothly rounded, not capitate, and without a calyptra. Cells 10-16 μ in diameter, 3.7-4 μ long; not constricted at crosswalls; cell contents pale with large quadrangular alveolations or vacuoles. Found in the tychoplankton, backwater pools and slowly flowing water.

Oscillatoria limosa (Roth) C. A. Agardh

Fig. 10

Trichomes usually forming a dark blue-green or brownish plant mass attached to submerged objects or forming films on sandy bottoms, rarely solitary or loosely entangled among filamentous algae; straight, tapering little or not at all toward apex. Apical cell rotund, the outer membrane thickened but without a definite calyptra. Cells 12-20 μ in diameter, 3.7-5 μ long, not constricted at crosswalls, which are usually granular. Common in stagnant backwaters and small ponds cut off by receding waters, in the tychoplankton.

Oscillatoria nigra Vaucher

Fig. 12

Trichomes aggregate to form a thick, mucilaginous blackish-green plant mass on submerged objects, becoming free-floating; straight or slightly entangled and slightly tapering toward the apex, which is straight or curved. Apical cell rotund, not capitate, and without calyptra. Cells 8-10 μ in diameter, 3.5-4.5 μ long; slightly constricted at the crosswalls. Common in backwater sloughs and in Provo Bay.

Oscillatoria tenuis C. A. Agardh

Fig. 11

Trichomes aggregated to form a blue-green mass, sometimes becoming scattered and appearing singly among other algae. Straight or slightly flexous, especially at the anterior end, which does not taper. Apical cell convex, smooth, and not capitate; outer membrane sometimes slightly thickened; homogeneous sheath frequently present. Cells 4-12 μ in diameter, 2.5-6 μ long; constricted at the crosswalls, which are granular. Very common in backwater ponds and swamps and in the tychoplankton. Most common from Provo Bay.

CHLOROPHYTA

Actinastrum gracilimum G. M. Smith

Fig. 23

Cells cylindrical, with slightly narrowed to abruptly truncate poles, forming colonies or individuals with the long axis of the cells radiating in all planes from a common center; cells 2 μ in diameter, 17-20 μ long, colonies 35-45 μ in diameter. Common in the plankton of Provo Bay and Powell's Slough during the summer. New record for Utah.

Actinastrum Hantzschii Lagerheim

Fig. 22

Cells spindle-shaped or cylindrical, narrowed toward the apices, arranged in simple or compound colonies of 4 or 8 with long axes of cells radiating from a common point, cells 4-6 μ in diameter, 19-22 μ in length. Common in the plankton of Provo Bay and Powell's Slough during the summer. New record for Utah.

Ankistrodesmus falcatus (Corda) Ralfs

Fig. 24

Cells needlelike to spindle-shaped, solitary or in clusters of 2-32, not enclosed by a sheath; chloroplast 1, a parietal plate without pyrenoids; cells 2.5 μ in diameter, 30 μ long. Intermingled with other algae in Powell's Slough. Not previously reported for Utah Lake.

Closterium venus Kuetz.

Fig. 14

Cells small, 8-9 times longer than their diameter, strongly curved, outer margin 150° - 160° of arc, inner margin not tumid, gradually attenuated to the apices which are acute or acutely rounded; cell wall smooth, colorless; chloroplasts ridged, with two pyrenoids; terminal vacuoles large, with a number of moving granules. Found in the euplankton and in the shallow backwater pools.

Gloeocystis ampla (Kuetz.) Lagerheim

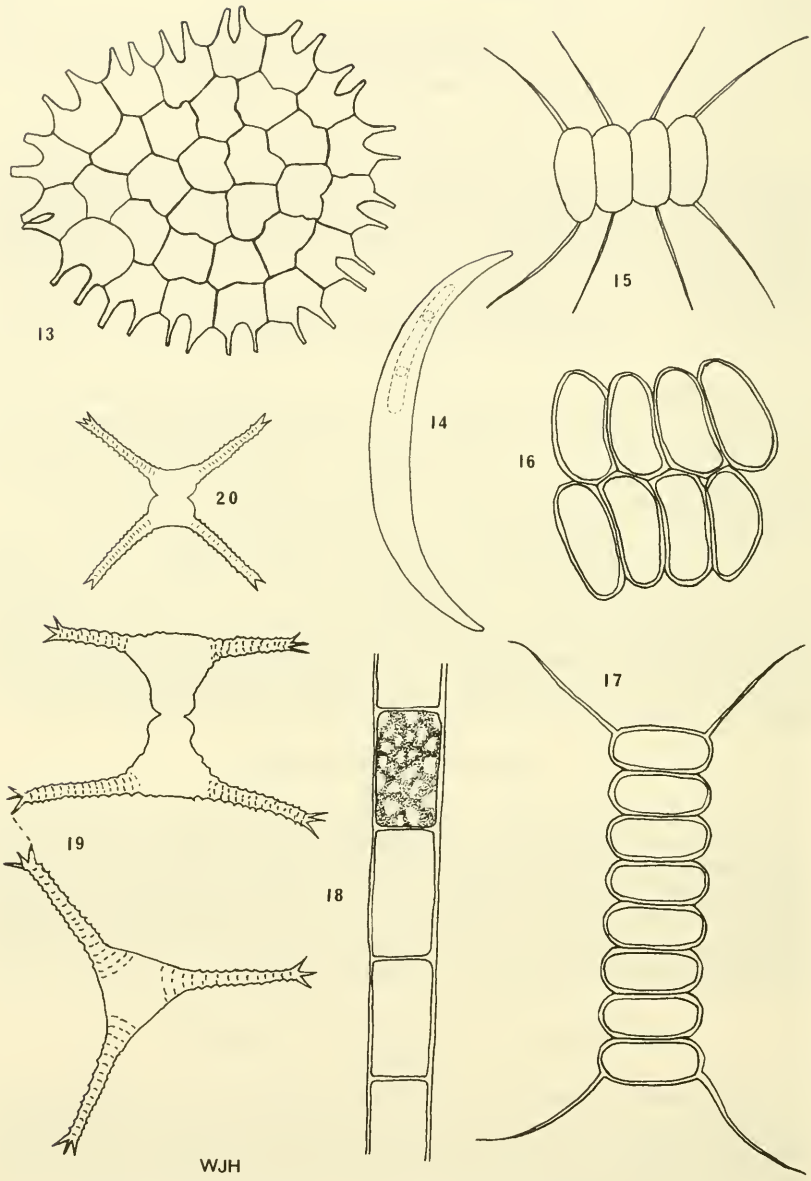
Fig. 21

Cells ovoid or oblong, arranged in amorphous or somewhat globular colonies, embedded in gelatinous envelopes, the sheath of each cell or group of cells distinct and angular from mutual compression; cells 7.5-12.5 μ in diameter, 12-17 μ long. Rare in the plankton. New record for Utah Lake.

Micractinium pusillum Fresenius

Fig. 26

A free-floating colony of 4-16 spherical cells arranged in groups of 4, forming a pyramid or square; free walls beset with 1-5 finely



13. *Pediastrum Boryanum* (Turp.) Meneghini 550X
14. *Closterium venus* Kuetz.
15. *Scenedesmus abundans* var. *brevicauda* G. M. Smith 1000X
16. *S. arcuatus* var. *platydisca* G. M. Smith 1200X
17. *S. quadricauda* var. *parvus* G. M. Smith 900X
18. *Microspora floccosa* (Vauch.) Thuret 900X
19. *Staurastrum paradoxom* f. Meyen 500X
20. *St. natator* f. West 800X

tapering setae; chloroplast a parietal cup with one pyrenoid. Cells 3-7.5 μ in diameter, setae 20-35 μ long. New record for Utah.

Microspora floccosa (Vauch.) Thuret

Fig. 18

Walls relatively thin, sections not always evident in the mid-region of the cell. Cells cylindrical or slightly swollen; 8-12 μ in diameter, 20-45 μ long. Chloroplast usually reticulate. Found in warm backwater ponds and swamps. New record for Utah.

Pediastrum boryanum (Turp.) Meneghini

Fig. 13

Colony entire, cells 5-6 sided with smooth or granular walls; peripheral cells with outer margins extended into 2 blunt-tipped processes; cells up to 14 μ in diameter, 21 μ long. Common in the eu- and tychoplankton in the lake and generally distributed throughout the swamps.

Planktospharea gelatinosa G. M. Smith

Fig. 27

A free-floating colony of spherical cells compactly grouped within a mucilaginous, homogeneous envelope; chloroplasts several, angular, parietal discs, each with a pyrenoid. Cells 20 μ in diameter. Common in the plankton during the late summer in Powell's Slough. New record for Utah.

Scenedesmus abundans var. *brevicauda* G. M. Smith

Fig. 15

Cells oblong or ovate, in a linear series of four. The terminal cells with 1 polar spine and 1 spine on lateral wall, inner cells with a spine at each pole. Cells 2.5-5 μ in diameter, 5-8 μ long. Rare in the plankton at several locations. New record for Utah.

Scenedesmus arcuatus var. *platydisca* G. M. Smith

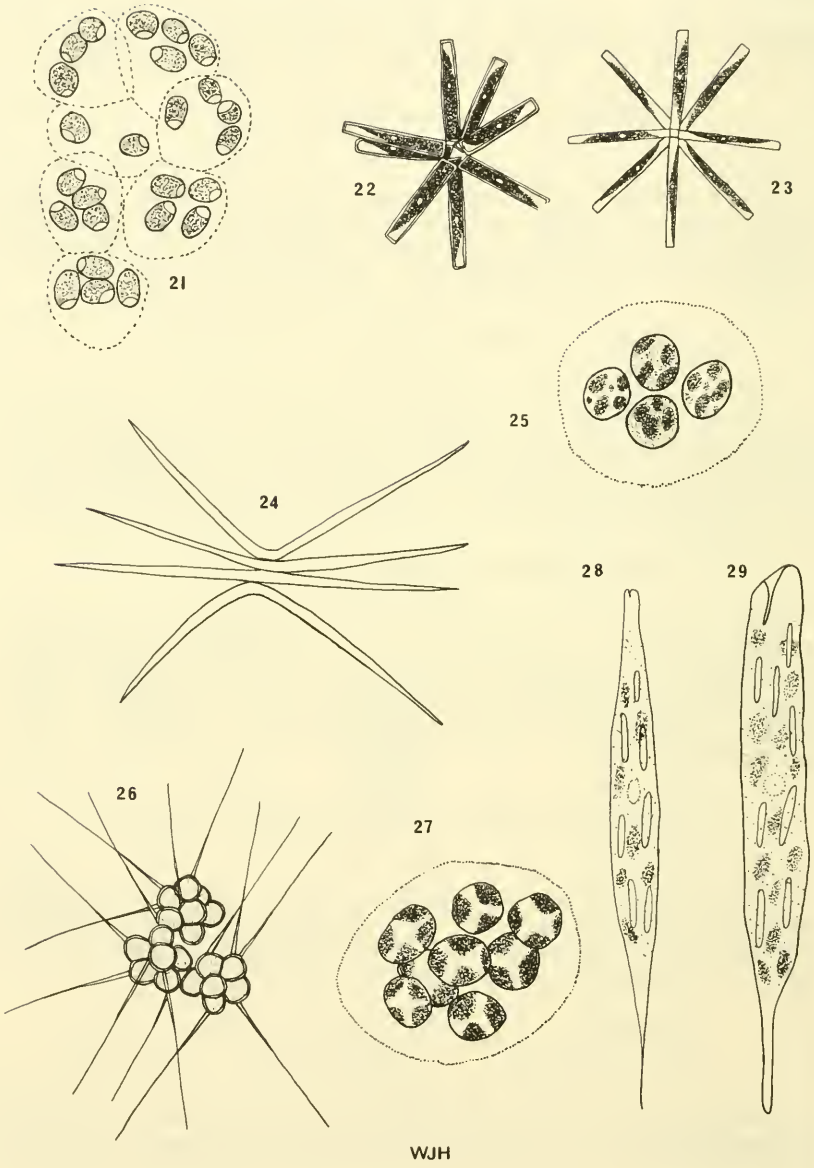
Fig. 16

Plant composed of 8 cells arranged in a flat, double series; cells oblong-elliptic, 4-6 μ in diameter, 8-12 μ long. Planktonic, rare. New record for Utah.

Scenedesmus quadricauda var. *parvus* G. M. Smith

Fig. 17

Colony composed of 2-16 cylindrical-ovate cells in a single series; inner cells spineless; outer cells with a long spine at each pole. Com-



21. *Gleocystis ampla* (Kuetz.) Lager 400X
22. *Actinastrum Hantzschii* Lager 500X
23. *A. gracilimum* G. M. Smith 500X
24. *Ankistrodesmus falcatus* (Corda) Ralfs. 500X
25. *Chlorobotrys regularis* (W. West) Bohlin 500X
26. *Micractinium pusillum* Fresenius 400X
27. *Planktospharea gelatinosa* G. M. Smith 400X
28. *Euglena acutissima* Lemm. 500X
29. *E. acus* Ehrenb. 400X

mon in Provo Bay and Powell's Slough during the summer. New record for Utah.

Staurastrum natator West forma?

Fig. 20

Length 14 μ, width 14 μ, isth. 5 μ. Very rare and when seen the plants have been very small, making positive identification difficult. New record for Utah.

Staurastrum paradoxum Meyen forma?

Fig. 19

Cells 62-80 x 82-100 μ isth. 12 μ. Very common in the eu- and tychoplankton during the early spring. New record for Utah Lake.

Euglenophyta

Euglena acus Ehrenb.

Fig. 29

Cell cylindrical to spindle-shaped, anterior end narrowed and truncate; narrowed posteriorly into a colorless point, pellicle indistinctly spirally striated, slightly metabolic; cells 177 μ long, 20 μ in diameter; chloroplasts numerous discoids; paramylum bodies 2 to several long rods. Found to be somewhat abundant in Provo Bay and Powell's Slough during the summer. Not previously reported for Utah Lake.

Euglena acutissima Lemm.

Fig. 28

Cell cylindrical, elongated, anterior end narrowed with tip truncated or blunt; region anterior to posterior part of reservoir hyaline; extended posteriorly into a prominent, sharp-pointed colorless tip; pellicle longitudinally striated, slightly metabolic; cell 135-140 μ long, 12 μ in diameter; chloroplasts numerous, discoidal; paramylum bodies several, rodlike, located anterior and posterior to nucleus; somewhat abundant in same areas as *E. acus*. New record for Utah.

Chrysophyta

Characiopsis cylindrica (Lambert) Lemm.

Fig. 5

Cells club-shaped to cylindrical, rounded at the anterior end and tapering posteriorly to a narrow base, cells 45 μ long, 10 μ in diameter. Found to be rare in Provo Bay during late summer. New record for Utah.

Chlorobotrys regularis (W. West) Bohlin

Fig. 25

A spherical colony of 2-8 globose cells regularly arranged within a hyaline, gelatinous envelope; chromatophores, several parietal discs; a conspicuous pigment spot usually visible; cells 12-15 μ in diameter; rare. New record for Utah.

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THE LIZARD *LEIOLOPISMA SMITHI* COCHRAN A JUNIOR SECONDARY HOMONYM OF *MOCOA SMITHII* GRAY

James D. Fawcett[1] and Hobart M. Smith[1]

A recent note (Campden-Main, 1969) declares the name *Leiolopisma smithi* Cochran, 1941, subjectively unavailable as a junior synonym of *Leiolopisma eunice* Cochran, 1927, both based on Thailand material. Rather remarkably, *L. smithi* Cochran has been objectively (although not irreversibly) unavailable from the time of its first proposal as a junior secondary homonym of the New Zealand *Mocoa smithii* Gray, 1845, which was placed in "*Liolepisma*" as early as 1897 (Lucas and Frost, 1897:277), in "*Lygosoma* (*Leiolopisma*)" as early as 1937 (Smith, 1937:223), and has regularly been placed in *Leiolopisma* ever since McCann's monograph appeared in 1955 (p. 96).

According to Article 59 of the International Code of Zoological Nomenclature, a junior secondary homonym (the younger of two names now placed in the same nominal genus but originally proposed in different nominal genera) is unavailable so long as it is regarded congeneric with the senior name, but, with one exception, is available for use if allocated to a different genus from that of the senior name. The exception involves only those junior secondary homonyms objectively replaced prior to 1961 because of their junior homonymy; such names cannot be revived even when placed in a genus different from the senior name.

Leiolopisma smithi Cochran, 1941, is clearly a junior secondary homonym of *Leiolopisma smithii* (Gray, 1845). It need not, however, be replaced objectively since *Leiolopisma eunice* Cochran, 1927, is a subjective synonym (senior, at that), according to Campden-Main (1969). If, on the contrary, any future worker declares *Leiolopisma smithi* Cochran a species distinct from *eunice* and from any other named species, it would have to receive a substitute name, assuming that it remains in the same genus as *Mocoa smithii* Gray.

It is extraordinary that this homonymy has been so widely overlooked. *Mocoa smithii* Gray is treated in Boulenger's Catalog (1887: 274) and in Malcolm Smith's group revision (1937:223), but was overlooked by Cochran (1941), Taylor (1963), and Campden-Main (1969); and *Leiolopisma smithi* Cochran was overlooked in Mittleman's group synopsis (1952) and in McCann's regional review (1955). The literature citations to these names of which we are aware are as follows.

Leiolopisma smithii Gray

Mocoa smithii Gray, 1845:82; Gray, 1867:4; Buller, 1871:6; Hutton, 1872:168.
Lampropholis smithii Fitzinger, 1861:403; Jouan, 1869:80.

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Eurepes smithii, Steindachner, 1867:47.

Lygosoma smithii, Boulenger, 1887:274-275; Werner, 1895:22; Werner, 1901:383; Hutton, 1904:39; Camp, 1923:413; Hutton and Drummond, 1923:379; Sladden and Falla, 1928:289; Smith, 1937:223; Fell, 1948:38; Hard. 1953-4:146.

Liolepisma smithii, Lucas and Frost, 1897:277.

Lygosoma (*Leiolopisma*) *smithii*, Smith, 1937:223; Barwick, 1959:376.

Leiolopisma smithii, Mittleman, 1952:30; McCann, 1955:96-98; McCann, 1956:49; Robb, 1965:66; Sharell, 1966:77; Whitaker, 1968:640.

Mocoa zealandica (*part.*), Günther, 1875:13.

Leiolopisma smithi Cochran

Leiolopisma smithi Cochran, 1941:238-239; Cochran, 1961:122; Taylor, 1963:1035-1036; Campden-Main, 1969:842-843.

Synonyms for these names include *Leiolopisma eunice* Cochran, 1927, a senior synonym of *L. smithi* Cochran, *fide* Campden-Main (1969); *Lygosomella aestuosa* Girard (1858), a junior synonym of *L. smithii* (Gray), *fide* McCann (1955); and *Norbea isolata* Hutton, 1872, a synonym of *L. smithii* (Gray) *fide* Boulenger (1887:274).

Several nomenclaturally distinct names have arisen from *Leiolopisma*, proposed by Duméril and Bibron in 1839. The generic indices (Schulz et al., and Neave) recognize as invalid (but nomenclaturally distinct) *Leiolepisma* Fitzinger (1843:22) and *Liolopisma* Agassiz (1847:204, 212). *Liolepisma* apparently first appeared in Boulenger (1887:211, 215), and is of similar status. *Leiolipisma* of A. S. and A. Wilkinson (1952) is apparently merely an erroneous subsequent spelling, without nomenclatural status. Since *Leiolopisma* and *Liolepisma* are nomenclaturally different genera (Art. 56[a] of the International Code), and since subgeneric names are nomenclaturally equal to generic names (Art. 43), with one exception (Art. 56[c], homonyms of identical date), the earliest usage of the trivial name *smithii* Gray, 1845, in *Leiolopisma* occurred in Malcolm Smith's revision of *Lygosoma* in 1937 (*i.e.*, as *Lygosoma* [*Leiolopisma*] *smithii* [Gray, 1845]), thus preceding *Leiolopisma smithi* Cochran (1941) by 4 years.

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ADDITIONS TO THE KNOWLEDGE OF THE HERPETOFAUNA OF OAXACA, MEXICO

Hobart M. Smith[1]

Among specimens recently collected by Mr. Thomas MacDougall for the University of Colorado Museum are four species of reptiles not previously, or rarely, recorded from the state of Oaxaca. I am indebted to Mr. Thomas MacDougall for obtaining this and much other material, and to Dr. T. Paul Maslin for provision of facilities for its study and care.

Barisia gadovi levigata Tihen. Since this subspecies was originally described (Tihen, 1949:231-233, pl. 2) from "Valley of Oaxaca" and "Mts. W Oaxaca, 9000 ft.," no new material has been noted in the literature except for mention by Bogert and Porter (1967:19) of occurrence at Tejocotes, 2500 m, Oax. Accordingly a specimen taken in 1968 at Lachiguiri, 7000 ft, Oax., is of special interest.

The specimen is a juvenile, 37 mm S-V, tail 68 mm. Its scale characters agree in detail with Tihen's description, except that there appear to be 14 dorsal scale rows and 54 dorsals rather than the expected 16 rows and 45-47 dorsals; however, the specimen is so small that accurate counts are virtually impossible to make. The critical characters of the head scales are precisely as described. Of greatest interest is the juvenile pattern, rather markedly different from that of the adult. A dark brown band extends down each side of head and body, fading out on tail; the band contains fine, superimposed light and dark lines; the dorsal surface of head, body, and tail is light tan, 8 scalerows wide at midbody; a series of 10 small, elongate dark brown spots on midline of body, between axilla and hind leg, and one spot on base of tail; each spot about two scales long and one wide, separated from others by about its own length; a dark streak down the center of each of the 12 rows of ventrals except the two midventral rows, the streaks broader on more lateral rows, becoming fine and interrupted on more medial rows.

Rhadinella schistosa Smith. No new material of this species has been reported since it was described some 30 years ago (Smith, 1941). Accordingly, a specimen (CUM 39790) taken in May 1969 at Vista Hermosa, Comaltepec, Ixtlán, Oaxaca, is of special interest in confirmation of existence of the species, and in extending its known range some 85 miles southeastward from the type locality at Cuautlapan, Veracruz. The habitat is much the same at both localities, indicating a range along the foothills of the central plateau, perhaps as far south as the Isthmus of Tehuantepec and as far north as southern Tamaulipas.

The specimen is a female 237 mm in total length, tail 45 mm; ventrals 154, caudals 38; labials 8-8; oculars 1-2; other scutellation, color, and pattern as originally described.

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Sibon nebulata nebulata (Linnaeus). In his monograph of the Dipsadinae, Peters (1960:200) noted Mexican specimens only from the states of Campeche, Chiapas, Guerrero, Michoacán, Quintana Roo, and Yucatán. Smith and Taylor (1945:126) noted its occurrence also in Oaxaca, Tabasco, and Vercruz, based respectively upon Gadow's (1905:196, 225) report for "La Raya," Boulenger's (1894: 293-294) for Teapa, and Cope's (1885:382) for Jicaltepec (the latter confirming Sumichrast's [1873:247, 249] vague notation of the species in the state of Veracruz). A specimen (CU 40009) taken at Progreso, Palomares, Juchitán, Oax., in 1968, provides a more reliable record for Oaxaca. Substantiative records have appeared in the literature for both Veracruz and Tabasco, as well as for several other states with previous records.

In addition, records have now appeared for Jalisco (Dixon, Sabbath, and Worthington, 1962:96), Colima (Duellman, 1958:12, 17) and Nayarit (Zweifel, 1959:7). Records of occurrence in southern Sinaloa, Tamaulipas, and San Luis Potosí, as well as eastern Hidalgo and Puebla, may be expected.

Xenodon rabdocephalus mexicanus Smith. Two specimens (CUM 40047-8) are from Progreso, Palomares, Juchitán, Oax., taken in 1968; and one (CUM 40049) is from Palomares, Juchitán, Oax., taken in 1969. Smith and Taylor (1945:153) record this taxon from the states of Chiapas, Guerrero, Tabasco, and Veracruz. Since then it has been recorded from Quintana Roo (Peters, 1953:231), and we are aware of one specimen (No. 26826) in the Museum of Comparative Zoology from Chichen Itza, Yucatán.

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NEW SYNONYMY IN AMERICAN BARK BEETLES (SCOLYTIDAE: COLEOPTERA)[1]

Stephen L. Wood[2]

Recent opportunities to borrow types and to visit major museums in connection with a comprehensive review of North and Central American Scolytidae have resulted in the discovery of much unpublished synonymy. In order to make this information available to others and to establish a basis for names currently used in identification work, it is published here rather than to await publication of the monograph. All species treated below occur in continental America north of Panama. Following the section on generic synonymy, species are treated in alphabetical order for convenience of reference. With three exceptions, at the species level only representatives of the subfamily Hylesininae are included.

Genus *Cnemonyx* Eichhoff

Cnemonyx Eichhoff, 1868, Berliner Ent. Zeitschr. 12:150 (Type-species: *Cnemonyx galeritus* Eichhoff, monobasic).

Ceratolepsis Chapuis, 1869, Synopsis des Scolytides, p. 52 (Type-species; *Ceratolepsis jucundus* Chapuis, monobasic). *New synonymy.*

Loganius Chapuis, 1869, Synopsis des Scolytides, p. 52 (Type-species: *Loganius flavicornis* Chapuis, monobasic). *New synonymy.*

More than 20 species in this complex are now known from North and Central America and almost an equal number from South America. While the variability, particularly in the antennal club, is great, thereby giving characters of generic value in some groups, species intermediate in all generic characters abound in this genus, making it impossible to recognize more than one genus having any taxonomic meaning. The names *Ceratolepsis* Chapuis and *Loganius* Chapuis are here placed in synonymy under *Cnemonyx* Eichhoff. A more elaborate treatment of this synonymy will appear later.

Genus *Gymnochilus* Eichhoff

Gymnochilus Eichhoff, 1867, Berliner Ent. Zeitschr. 11:399 (Type-species: *Gymnochilus zonatus* Eichhoff, monobasic).

Problechilus Eichhoff, 1878, Mem. Soc. Roy. Sci. Liége (2)8:46,167 (Replacement name for *Gymnochilus* Eichhoff).

Because of supposed homonomy with *Gymnochila* Klug (1834), Eichhoff replaced his name *Gymnochilus* with *Problechilus.* Since then there has been some confusion among workers as to which name should be used for this genus. The two names differ in gender;

[1]Most of the research on which this paper was based was supported by grants from the National Science Foundation.

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consequently, both are available. For this reason the replacement name *Problechilus* is unnecessary and the senior name *Gymnochilus* should be used in its place.

Genus *Pseudothysanoes* Blackman

Pseudothysanoes Blackman, 1920, Mississippi Agric. Expt. Sta. Tech. Bull. 9:46 (Type-species: *Pseudothysanoes drakei* Blackman = *rigidus* LeConte, original designation).

Cryptocleptes Blackman, 1920 (nec Simon, 1884), Mississippi Agric. Expt. Sta. Tech. Bull. 9:51 (Type-species: *Cryptocleptes dislocatus* Blackman, monobasic). *New synonymy.*

Chalcohyus Blackman, 1943, Proc. U.S. Nat. Mus. 93:363 (Type-species: *Chalcohyus securigerus* Blackman, monobasic). *New synonymy.*

Cryptulocleptus Wood, 1962, Gt. Basin Nat. 22:76 (Replacement name for *Cryptocleptes* Blackman, preoccupied).

As originally established, the genera *Pseudothysanoes* Blackman, *Cryptocleptes* Blackman, and *Chalcohyus* Blackman were easily characterized and recognized. However, about 70 species have been described in this group since then and what were once distinct groups are now nothing more than variations in one large, diverse genus. Segmentation of the antennal club varies from deeply grooved sutures marked by rows of setae to complete absence of all indications of sutures. The antennal club varies from large and broad to small and very elongate, with all degrees of variation between. The bifid protibial character used by Blackman is restricted to the female sex and may occur in some or all species of almost every species group in the genus. I see no alternative to placing *Cryptocleptes* and *Chalcohyus* in synonymy under the senior name *Pseudothysanoes*.

Aphanocleptus Wood (1960, Gt. Basin Nat. 20:63) is retained as a subgenus of *Pseudothysanoes* for those species with an exceedingly short antennal scape.

Genus *Scolytodes* Ferrari

Scolytodes Ferrari, 1867, Die Forst- und Baumzuchtschädlichen Borkenkäfer, p. 77 (Type-species: *Scolytodes laevigatus* Ferrari, monobasic).

Hexacolus Eichhoff, 1868, Berliner Ent. Zeitschr. 11:399 (Type-species: *Hexacolus glaber* Eichhoff, monobasic). *New synonymy.*

Prionosceles Blandford, 1897, Biol. Centr. Amer., Coleopt. 4(6):177 (Two species); Hopkins, 1914, Proc. U.S. Nat. Mus. 48:128 (Type-species: *Prionosceles atratus* Blandford, subsequent designation). *New synonymy.*

The three generic names *Scolytodes* Ferrari, *Hexacolus* Eichhoff, and *Prionosceles* Blandford have long been treated as distinct. However, since their description more than a hundred species have been added to the complex and many more are awaiting description. It is now apparent that the sculpture of the pronotum grades from smooth (*Scolytodes*), through minutely asperate or tuberculate (*Prionosceles*) to finely to very coarsely asperate (*Hexacolus*) and is not usable as a generic character. There are a few species in which one sex of a species would be placed in one genus and the other sex in a

different genus if sculpture of the pronotum were the only character considered for separating genera. Similarly, the broad protibia of *Prionosceles* is developed gradually in one species group, but that character is not correlated with other characters that could be used to recognize genera.

The genus *Scolytodes*, as considered here, is a large and diverse group biologically as well as anatomically. It includes monogamous and polygamous species, phloeophagous and xylophagous species, species forming a cave-type tunnel with the larvae feeding in congress to those forming a complex radiate *Pityophthorus*-type system of galleries with individual larval mines, and many other variations. However, in this diversity of habits I presently see no correlation with anatomical structure that would support the subdivision of the group on any natural lines. Therefore, *Hexacolus* and *Prionosceles* are here placed in synonymy under the senior name *Scolytodes*.

Chaetophloeus coronatus (Chapuis), n. comb.

Phloeosinus coronatus Chapuis, 1869, Synopsis des Scolytides, p. 39 (Holotype, male; Yucatan, Mexico; Brussels Mus.).

The unique holotype of this species was examined and found to represent a species of *Chaetophloeus* near *brasiliensis* Blackman.

Chaetophloeus heterodorus (Casey)

Renocis heterodoxus Casey, 1886, California Acad. Sci. Bull. 6:258 (Holotype, male; Reno, Nevada; U.S. Nat. Mus.).

Renocis brunneus Blackman, 1940, Proc. U.S. Nat. Mus. 88:389 (Holotype, female; Cloudcroft, New Mexico; U.S. Nat. Mus.). *New synonymy.*

Renocis fuscus Blackman, 1940, Proc. U.S. Nat. Mus. 88:391 (Holotype, female; Williams, Arizona; U.S. Nat. Mus.). *New synonymy.*

Renocis commixtus Blackman, 1940, Proc. U.S. Nat. Mus. 88:392 (Holotype, female; Williams, Arizona; U.S. Nat. Mus.). *New synonymy.*

This species occurs from Manitoba to western Texas westward to the Pacific Coast in numerous species of shrubs. The holotypes, paratypes, and more than 200 other specimens of *heterodoxus* Casey, *brunneus* Blackman, *fuscus* Blackman, and *commixtus* Blackman were examined. Only one species is represented by this material. Blackman's three names, therefore, are here placed in synonymy under *heterodoxus* (Casey).

Chaetophloeus mexicanus (Blackman)

Renocis mexicanus Blackman, 1940, Proc. U.S. Nat. Mus. 88:397 (Holotype, female; Guadalajara, Jalisco, Mexico; U.S. Nat. Mus.).

Renocis mexicanus Eggers, 1950 (nec Blackman, 1940), Ent. Blätt. 45-46:149 (Holotype, evidently a male; Mexico; Schedl Coll.). *New synonymy.*

The holotype of *mexicanus* Eggers was examined and found to be in very poor condition. However, since *mexicanus* Blackman is the only known species of this size having two pairs of submarginal crenulations at the bases of the elytra, it is reasonably certain they

are synonyms. The size, body proportions, and general surface sculpture are the same. All setae are completely abraded on Egger's type.

Chramesus asperatus Schaeffer

Chramesus asperatus Schaeffer, 1908, J. New York Ent. Soc. 16:220 (Syntypes; Chiricahua Mts., Arizona; U.S. Nat. Mus.); Blackman, 1928, J. Washington Acad. Sci. 28:539 (Lectotype, female).

Chramesus gibber Blackman, 1938, J. Washington Acad. Sci. 28:541 (Holotype, female; Cloudcroft, New Mexico; U.S. Nat. Mus.). *New synonymy.*

The lectotype and male lectoallotype of *asperatus* Schaeffer and the holotype and male allotype of *gibber* Blackman were compared directly to one another and to long series from Cloudcroft, New Mexico, and from the Chiricahua Mountains, Arizona. It is now clear that the differences are not as great as described by Blackman and that they fall well within the limits of variation in this abundant species.

Chramesus pumilus Chapuis

Rhopalopleurus pumilus Chapuis, 1869, Synopsis des Scolytides, p. 47 (Holotype, male; Teapa, Tabasco, Mexico; Brussels Mus.).

Chramesus tumidulus Blandford, 1897, Biol. Centr. Amer., Coleopt. 4(6):170 (Lectotype, female; Las Mercedes, Guatemala; British Mus. Nat. Hist., present designation). *New synonymy.*

Chramesus panamensis Blackman, 1943, Proc. U.S. Nat. Mus. 94:391 (Holotype, female; Panama Canal Zone; U.S. Nat. Mus.). *New synonymy.*

Chramesus mexicanus Schedl, 1949, Rev. Brasil Biol. 9:264 (Holotype, female; Comitan, Chiapas, Mexico; Schedl Coll.). *New synonymy.*

From the two syntypes in Blandford's type series, I here designate the female from Las Mercedes, Guatemala, as the lectotype of *tumidulus* Blandford. This lectotype and the holotypes of *pumilus* Chapuis and *mexicanus* Schedl, and the entire type series of *panamensis* Blackman were compared directly to specimens in my collection.

They all definitely represent the same, abundant, widely distributed, easily recognized species. It breeds in *Canavalia villosa* from central Mexico to Panama.

Chramesus subopacus Schaeffer

Chramesus subopacus Schaeffer, 1908, J. New York Ent. Soc. 16:22 (Syntypes; Huachuca Mts., Arizona; Brooklyn Mus. and U.S. Nat. Mus.); Blackman, 1938, J. Washington Acad. Sci. 28:541 (Lectotype, female; U.S. Nat. Mus.).

Chramesus canus Blackman, 1938, J. Washington Acad. Sci. 28:541 (Holotype, female; Tallulah, Louisiana; U.S. Nat. Mus.). *New synonymy.*

Lectotype and paralectotypes of *subopacus* Schaeffer were compared directly to the holotype, allotype, and paratype of *canus* Blackman and with other specimens from Texas to Honduras. They all represent the same easily recognized species. Blackman's name must therefore be placed in synonymy.

Cnesinus costulatus Blandford

Cnesinus costulatus Blandford, 1896, Biol. Centr. Amer., Coleopt. 4(6):137 (Lectotype, female; Volcan de Chiriqui, Chiriqui, Panama; British Mus. Nat. Hist.).

Cnesinus similis Blackman, 1943, Proc. U.S. Nat. Mus. 94:375 (Holotype, female; Porto Bello, Panama; U.S. Nat. Mus., 56552). *New synonymy.*

From the six specimens remaining in the British Museum (Natural History) of Blandford's nine syntypes, I have selected and here designate the first, from Volcan de Chiriqui, as the lectotype of *Cnesinus costulatus* Blandford. The lectotype was compared to my homotypes from Pandora, Limon Prov., Costa Rica, and these to the holotype of *similis* Blackman. All represent the same species.

Cnesinus gracilis Blandford

Cnesinus gracilis Blandford, 1896, Biol. Centr. Amer., Coleopt. 4(6):141 (Holotype, female; Volcan de Chiriqui, Chiriqui, Panama; British Mus. Nat. Hist.).

Cnesinus substrigatus Blackman, 1943, Proc. U.S. Nat. Mus. 94:376 (Holotype, female; Santander, Colombia; U.S. Nat. Mus.). *New synonymy.*

The female holotypes of both *gracilis* Blandford and *substrigatus* Blackman were compared to females from Finca Gromaco, Puntarenas Prov., Costa Rica, and were found to be identical. In all, 40 specimens of this species from Honduras to Colombia were examined.

Cnesinus setulosus Blandford

Cnesinus setulosus Blandford, 1896, Biol. Centr. Amer., Coleopt. (Lectotype, male; Tole, Chiriqui, Panama; British Mus. Nat. Hist., present designation).

Cnesinus flavopilosus Schedl, 1940, An. Esc. Nac. Cienc. Biol., Mexico 1:333 (Holotype, sex?; Comitan, Mexico; Schedl Coll.). *New synonymy.*

Cnesinus panamensis Blackman, 1943, Proc. U.S. Nat. Mus. 94:372 (Holotype, male; Panama; U.S. Nat. Mus.). *New synonymy.*

Cnesinus cognatus Blackman, 1943, Proc. U.S. Nat. Mus. 94:372 (Holotype, female; El Peten Prov., Guatemala; U.S. Nat. Mus.). *New synonymy.*

This is a highly variable species in which no two series of the 57 specimens examined were exactly alike. Specimens from Mexico are rather strikingly different from some of those from Panama; however, series taken from Guatemala and Honduras appear to completely bridge any suggested gap between them. Representatives of my Esquintla, Guatemala, series were compared by Schedl to his type of *flavopilosus;* my Olanchito, Honduras, male homotype was compared directly to the holotype of *panamensis* Blackman; and another Olanchito, Honduras, female homotype was compared directly to the holotype of *cognatus* Blackman. All of these specimens were compared directly to the three male syntypes of *setulosus* Blandford. There is no doubt as to the synonymy of *setulosus*, *cognatus*, and *panamensis*.

Occasional Panama specimens have the eyes more widely separated and the pronotum less strongly strigose with the punctures

more isolated than do specimens from Mexico. Other Panama specimens and those from intermediate areas tend to be intermediate in one or both characters. It appears that only one species can be recognized in this material.

From Blandford's series of three male syntypes, I here designate the first, from Tole, Chiriqui, Panama, as the lectotype of *Cnesinus setulosus* Blandford.

Eupagiocerus dentipes Blandford

Eupagiocerus dentipes Blandford, 1897, Biol. Centr. Amer., Coleopt. 4(6):133 (Lectotype, male; El Tumbador, Guatemala; British Mus. Nat. Hist., present designation).

Eupagiocerus clarus Wood, 1965, Gt. Basin Nat. 25:33 (Holotype, female; Rio Viejo, Volcan de Chiriqui, Chiriqui, Panama; Wood Coll.). *New synonymy.*

From the three male syntypes in Blandford's series, I here designate the first, from El Tumbador, as the lectotype of *Eupagiocerus dentipes* Blandford. These three callow males were compared to black females of *clarus* Wood, in 1964, and found to differ in several respects. Later, when sexual differences were found and callow males from Costa Rica were compared to the syntypes, the synonymy was obvious.

Hylastes gracilis LeConte

Hylastes gracilis LeConte, 1868, Trans. Amer. Ent. Soc. 2:174 (Lectotype, female; Tahoe Valley, California; Mus. Comp. Zool., 958, present designation).

Hylastes vastans Chapuis, 1869, Synopsis des Scolytides, p. 17 (Holotype, female; Mexico; Brussels Mus.). *New synonymy.*

Hylastes nitidus Swaine, 1917, Dom. Canada Dept. Agric. Ent. Br. Bull. 14(1): 19 (Holotype, female?; Near Hot Springs, Las Vegas, New Mexico; Canadian Nat. Coll., 9246). *New synonymy.*

The types of *gracilis* LeConte, *vastans* Chapuis, and *nitidus* Swaine were all examined and compared directly to several specimens in my collection. All definitely fall within the limits of this somewhat variable species. While a majority of the specimens from a given geographical location were easily recognized as belonging to this species, occasional specimens exhibit frontal or perhaps other characters that are somewhat different. It is only through the examination of several series from such an area that complete intergradation between these aberrant individuals and the main population is observed. In view of this, the names *vastans* and *nitidus* are here placed in synonymy under the older name *gracilis*. The first specimen, a female, of LeConte's two syntypes is here designated as the lectotype.

Hylastes porculus Erichson

Hylastes porculus Erichson, 1836, Archiv Naturgesch. 2:49 (Pennsylvania: Berlin Zool. Mus.).

Hylastes swainei Eggers, 1934, Ent. NachrBl. 8:25 (Holotype, male; Frater, Ontario; U.S. Nat. Mus., 59125); Schedl, 1952, Ent. Blatt. 47-48:159.

Hylastes webbi Blackman, 1941, U.S. Dept. Agric. Misc. Pub. 417:10 (Holotype, female; Elmore, South Dakota; U.S. Nat. Mus.). *New synonymy.*

Hylastes canadensis Blackman, 1941, U.S. Dept. Agric. Misc. Pub. 417:15 (Holotype, female; Aweme, Manitoba; U.S. Nat. Mus.). *New synonymy.*

The Eichhoff specimen of *porculus* Erichson in the U.S. National Museum collection, used as the basis for this species for Blackman's (1941) revision of *Hylastes*, was compared to the holotypes of *webbi* Blackman, *canadensis* Blackman, and *swainei* Eggers and to selected specimens of *porculus* from eastern North America. Following the analysis of 168 specimens from throughout its range and the study of the types, it is apparent that only one species is represented. The names *webbi* Blackman, *canadensis* Blackman, and *swainei* Eggers are here placed in synonymy under the senior name *porculus* Erichson.

In Blackman's revision of the genus, *swainei* was placed in synonymy under *porculus*, although he saw no type material. Later, Schedl (1952), apparently on the basis of a study of two cotypes, proposed that the name be removed from synonymy. This action, as indicated above, was in error.

Hylastes tenuis Eichhoff

Hylastes tenuis Eichhoff, 1868, Berliner Ent. Zeitschr. 12:147 (Holotype, sex?; Amerique Boreale; evidently lost with Hamburg Mus.).

Hylastes pusillus Blackman, 1941, U.S. Dept. Agric. Misc. Pub. 417:23 (Holotype, female; Florida; U.S. Nat. Mus.). *New synonymy.*

Hylastes parvus Blackman, 1941, U.S. Dept. Agric. Misc. Pub. 417:24 (Holotype, female; Williams, Arizona; U.S. Nat. Mus.). *New synonymy.*

Hylastes minutus Blackman, 1941, U.S. Dept. Agric. Misc. Pub. 417:25 (Holotype, female; Lake Tahoe, Nevada; U.S. Nat. Mus.). *New synonymy.*

The type of *tenuis* Eichhoff was compared by J. M. Swaine to his homotypes that are identical to several specimens in my collection. These in turn were compared directly to the holotypes of *pusillus* Blackman, *parvus* Blackman, and *minutus* Blackman. Following my examination of more than 323 specimens, it is apparent that approximately two-thirds of the specimens from the Atlantic Coast states exhibit a median, impressed, often shining line on the frons; many of these are indistinguishable from the European *attenuatus* Erichson. Material from Louisiana rarely possessed this character, although it was present in the population; it was absent in material from the Western States. The features described by Blackman to distinguish *pusillus*, *parvus*, and *minutus* appear to be normal variations within a series. Therefore, only one species is recognized for the four names mentioned here.

Hylurgops planirostris (Chapuis)

Hylastes planirostris Chapuis, 1869, Synopsis des Scolytides, p. 21 (Lectotype, female; Suapan, Mexico; Brussels Mus.).

Hylurgops knausi Swaine, 1917, Dom. Canada Dept. Agric. Ent. Br. Bull. 14(1): 17 (Lectotype, female?; Cloudcroft, New Mexico; Canadian Nat. Coll., 9243). *New synonymy.*

From the four Chapuis syntypes in the Brussels Museum I here designate the first, a female from "Suapan," Mexico, as the lectotype of *Hylastes planirostris* Chapuis. These syntypes were compared to my homotypes of *Hylurgops knausi* Swaine and found to be identical. Swaine's name, therefore, is here placed in synonymy.

Hylurgops porosus (LeConte)

Hylastes porosus LeConte, 1868, Trans. Amer. Ent. Soc. 2:175 (Lectotype, female?; California; Mus. Comp. Zool., 957); Swaine, 1917, Dom. Canada Dept. Agric. Ent. Br. Bull. 14(1):16 (Removed second syntype from species).

Hylurgops lecontei Swaine, 1917, Dom. Canada Dept. Agric. Ent. Br. Bull. 14(1):16 (Holotype, female?; Colorado; Canadian Nat. Coll., 9242). *New synonymy.*

The types of both *porosus* LeConte and *lecontei* Swaine were examined and compared directly to one another and to several of my homotypes. After a complete review of this genus, in which several hundred specimens were examined, it is now clear that only one species is represented by these two names.

Leperisinus californicus Swaine

Leperisinus californicus Swaine, 1916, Canadian Ent. 48:190 (Holotype, female; San Diego, California; Canadian Nat. Coll., 9249).

Leperisinus hoferi Blackman, 1943, Proc. U.S. Nat. Mus. 94:394 (Holotype, female; Sabino Canyon, Arizona; U.S. Nat. Mus., 56573). *New synonymy.*

Leperisinus californicus Essig, 1957, Insects and mites of western North America, p. 519 (*nomen nudum*).

The holotypes of *californicus* Swaine and *hoferi* Blackman were examined and compared to specimens in my collection; they represent only one species. This species is now known to occur from North Dakota and Oklahoma west to Washington and California, and south to Chihuahua. Due to an unfortunate error, Essig designated a new species, *californicus*, in his book cited above, but a description was not included nor was a type designated.

Phloeosinus cristatus (LeConte)

Hylesinus cristatus LeConte, 1868, Trans. Amer. Ent. Soc. 2:169, 170 (Holotype, female; California; Carnegie Mus.).

Phloeosinus cristatus: LeConte, 1876, Proc. Amer. Philos. Soc. 15:381.

Phloeosinus chiricahua Blackman, 1942, Proc. U.S. Nat. Mus. 92:444 (Holotype, male; Chiricahua National Monument, Arizona; U.S. Nat. Mus., 55407). *New synonymy.*

Blackman divided this taxon into two species based on differences in the sculpture of the discal interstriae, on the impression of the sutural striae on the declivity, on the vestiture, and on the disjunct distributions. The material at hand, from Palo Alto, California, and Sedona, Arizona, has the character of the discal interstriae the reverse of that reported by Blackman; the second and third characters I am unable to detect, and a lack of collecting probably is responsible

for the apparent disjunct distributions. The differences in the discal interstriae are so slight and variable that separate species or even geographical races cannot be recognized from the material presently available for study. Until more substantial evidence is available I refer *chiricahua* Blackman to synonymy under *cristatus* (LeConte).

Phloeosinus cupressi Hopkins

Phloeosinus cupressi Hopkins, 1903, U.S. Bur. For. Bull. 38:35 (Holotype, male; Golden Gate Park, San Francisco, California; U.S. Nat. Mus., 55406).

Phloeosinus nitidus Swaine, 1924, Canadian Ent. 56:145 (Holotype, male; Santiam Nat. For., Oregon; Canadian Nat. Coll., 730). *New synonymy.*

Phloeosinus blackwelderi Blackman, 1943, Proc. U.S. Nat. Mus. 94:397 (Holotype, male; Ciricito, Canal Zone, Panama; U.S. Nat. Mus., 56576). *New synonymy.*

The holotypes of *cupressi* Hopkins, *nitidus* Swaine, and *blackwelderi* Blackman were all examined and were compared to my homotypes and to several additional specimens. A total of 166 specimens were examined from all parts of the known distribution. It is apparent that Blackman divided this species into two allopatric species on the Pacific Coast of North America, defined by differences in host, by supposedly smoother lateral interstriae, and by sinuate striae in the northern race. The discal interstriae of the northern race tend to be more coarsely, closely crenulate in specimens from Washington but finer in those from Alaska. The other characters vary about equally within series from both northern and southern areas. No character, except host, is sufficiently constant to be recognized in more than half of the available material. For these reasons, until reliable biological or other characters are found that will support a division, I must recognize only one species.

Blackman evidently failed to recognize the possibility of this species being introduced into Panama and described specimens from there as a distinct species. They are normal southern representatives of this species.

Phloeosinus fulgens Swaine

Phloeosinus fulgens Swaine, 1924, Canadian Ent. 56:147 (Holotype, male; Northfork, California; Canadian Nat. Coll., 732).

Phloeosinus splendens Blackman, 1942, Proc. U.S. Nat. Mus. 92:428 (Holotype, male; Pinehurst, Oregon; U.S. Nat. Mus., 55402). *New synonymy.*

Blackman erected *splendens* on the basis of a more uniformly granulate-punctate frons; of larger, more widely spaced pronotal punctures; of wider declivital interstriae 2; and of color differences. Following the examination of his type series, of the U.S. National Museum series of *fulgens*, and of material in my collection, including several homotypes, it is apparent that characters on which *splendens* was based are minute, obscure, and not consistently represented in specimens under either name in the material studied by Blackman. For these reasons the name *splendens* Blackman must be placed in synonymy under *fulgens* Swaine.

Phloeosinus hoppingi Swaine

Phloeosinus hoppingi Swaine, 1915, Canadian Ent. 47:364 (Lectotype, female; Camp 6, California; Canadian Nat. Coll., 6084).

Phloeosinus woodi Bright, 1966, Pan-Pacific Ent. 42:296 (Holotype, male; Cypress Camp near Hat Creek, Shasta Co., California; Wood Coll.). *New synonymy.*

My lectohomotypes of *hoppingi* Swaine, the holotype, allotype, and 30 paratypes of *woodi* Bright, and 48 other specimens were studied. Because of the slightly larger average size, I had not previously compared the *woodi* type series to *hoppingi*. There are no significant differences between the two; therefore, only one species is recognized.

Phloeosinus pini Swaine

Phloeosinus pini Swaine, 1915, Canadian Ent. 47:362 (Lectotype, female; Riding Mountains, Manitoba; Canadian Nat. Coll., 6083).

Phloeosinus alaskanus Blackman, 1942, Proc. U.S. Nat. Mus. 92:409 (Holotype, male; Eagle, Alaska; U.S. Nat. Mus., 55396). *New synonymy.*

The holotypes of both *pini* Swaine and *alaskanus* Blackman were examined and compared directly to some of my specimens. Series of specimens were examined from Alaska, Northwest Territories, Manitoba, Michigan, and Quebec—all taken from *Picea glauca* except for the type series of *pini* that was taken in *Pinus banksiana.* The minute differences on which *alaskanus* was based can be found as individual points of variation in a long series. Only one species can be recognized among the 84 specimens examined.

Phloeosinus punctatus LeConte

Phloeosinus punctatus LeConte, 1876, Proc. Amer. Philos. Soc. 15:382 (Lectotype, female; blue disk signifying Oregon; Mus. Comp. Zool., 978).

Phloeosinus rubicundulus Swaine, 1924, Canadian Ent. 56:144 (Holotype, female; Hossack Meadows, Tulare Co., California; Canadian Nat. Coll., 729). *New synonymy.*

Phloeosinus chamberlini Blackman, 1942, Proc. U.S. Nat. Mus. 92:470 (Holotype, male; Alturas, California; U.S. Nat. Mus., 55415). *New synonymy.*

This variable, polyphagous, abundant species is not easily recognized. After studying several hundred specimens from British Columbia to California, and after studying the type series of *punctatus* LeConte, *rubicundulus* Swaine, and *chamberlini* Blackman, I have very reluctantly concluded that only one species is represented by these names. The elytral vestiture is easily abraded, and its variability is determined more by beetle activity than by distribution or genetics.

Phloeosinus scopulorum neomexicanus Blackman

Phloeosinus neomexicanus Blackman, 1942, Proc. U.S. Nat. Mus. 92:460 (Holotype, male; Vermejo, New Mexico; U.S. Nat. Mus., 55412).

Phloeosinus texanus Blackman, 1942, Proc. U.S. Nat. Mus. 92:462 (Holotype, male; Montell, Uvalde Co., Texas; U.S. Nat. Mus., 55413). *New synonymy.*

Following the examination of 201 specimens from British Columbia to Texas and the holotypes of *scopulorum* Swaine, *neomexicanus* Blackman, and *texanus* Blackman, it was determined that Blackman's two names were based on exceedingly minute characters that do not distinguish populations in the field. They are therefore synonyms. Because of the lack of material available for study from Nevada, Idaho, and Oregon, *neomexicanus* is recognized as a distinct subspecies from *scopulorum*, although its validity is seriously questioned. Additional collecting will clarify its status.

Phloeosinus serratus (LeConte)

Hylesinus serratus LeConte, 1868, Trans. Amer. Ent. Soc. 2:169, 170 (Holotype, male; pink disk signifying "Middle States"; Mus. Comp. Zool., 977).

Phloeosinus serratus: LeConte, 1876, Proc. Amer. Philos. Soc. 15:381.

Phloeosinus utahensis Swaine, 1915, Canadian Ent. 47:363 (Lectotype, female; Stockton, Utah; Canadian Nat. Coll., 6087). *New synonymy.*

Phloeosinus juniperi Swaine, 1917, Dom. Canada Dept. Agric. Ent. Br. Bull. 14(1):10 (Lectotype, female; Scaffold Meadow, Tulare Co., California; Canadian Nat. Coll., 9257). *New synonymy.*

Phloeosinus aciculatus Bruck, 1931, Pan-Pacific Ent. 7:127 (Holotype, male; Chiricahua Mts., Arizona; California Academy of Sciences).

The types of *serratus* LeConte, *utahensis* Swaine, *juniperi* Swaine, and *aciculatus* Bruck were examined as well as the allotypes of Swaine's species and more than 200 specimens from Washington to Texas and Durango. The identity of *serratus* long remained a mystery because the male declivital interstriae 3 on the holotype included more teeth than is normal for this species. With more material now available the variation seen in LeConte's type is recognized as a moderately common variant in large series from New Mexico and western Texas. Presumably due to the paucity of specimens available for study from intermediate localities, three synonyms have been named from widely separated parts of its distribution, based on minor, variable characters. Based on the material available I see no possibility of recognizing geographical races, although occasional specimens may superficially appear to be strikingly different. The name *serratus* LeConte has priority over the names of Swaine and Bruck.

Phloeotribus asperatus Blandford

Phloeotribus asperatus Blandford, 1897, Biol. Centr. Amer., Coleopt. 4(6):166 (Holotype, male; Panajachel, Guatemala; British Mus. Nat. Hist.).

Phloeotribus sodalis Blandford, 1897, Biol. Centr. Amer., Coleopt. 4(6):168 (Lectotype, male; Cerro Zunil, Guatemala; British Mus. Nat. Hist.). *New synonymy.*

This very abundant species occurs in Central America from Guatemala to Costa Rica and in northern South America in *Celtis*, *Croton*, *Cedrela*, *Ficus*, *Hibiscus*, and perhaps many other host species. Following the examination of 260 specimens, including the type series of both *asperatus* Blandford and *sodalis* Blandford, I am

able to recognize only one species. The name *asperatus* has page priority; *sodalis* is placed in synonymy under it. Since *sodalis* was based on a syntypic series of three specimens, I here designate the first, a male from Cerro Zunil, as the lectotype of *sodalis* Blandford.

This species and *armatus* Blandford were mixed by Blandford, and specimens of both were placed under both names.

Phloeotribus frontalis (Olivier)

Scolytus frontalis Olivier, 1795, Entomologie, Coleopt. 4(78):13 (Type?; Amerique septentrionale).

Phloeophthorus moriperda Hopkins, 1907 (1905 preprint), Proc. Ent. Soc. Washington 7:77 (Lectotype, female; Irapuato, Guanajuato, Mexico; U.S. Nat. Mus.). *New synonymy.*

Two specimens of *Phloeophthorus granicollis* Eichhoff, presumed to be cotypes, were compared to specimens in my collection. *Eichhoff* (1896, Proc. U.S. Nat. Mus. 18:608) established the synonymy of his species with *frontalis* (Olivier). My specimens were compared to the male and female syntypes of *moriperda* Hopkins and were found to represent the same species. Hopkins' name, therefore, is placed in synonymy. The female syntype is here designated as the lectotype of *moriperda* Hopkins.

Phloeotribus liminaris (Harris)

Tomicus liminaris Harris, 1852, A treatis on some insects injurious to vegetation, p. 79 (Holotype, female; New England; Mus. Comp. Zool., 26428).

Phthorophloeus mississippiensis Blackman, 1921, Mississippi Agric. Expt. Sta. Tech. Bull. 10:4 (Lectotype, female; Agricultural College, Mississippi; U.S. Nat. Mus.). *New synonymy.*

Blackman described *mississippiensis* from a series of 26 specimens and referred to types and paratypes. Because he did not clearly designate a type, I here designate the female on which his description was based, and which he labeled as the type, to be the lectotype of *mississippiensis* Blackman. His type series was compared to my homotypes of *liminaris* and found to represent the same species. Blackman's name, therefore, is placed in synonymy.

Pseudothysanoes sedulus Blackman

Pseudothysanoes sedulus Blackman, 1928, New York Coll. For., Syracuse, Tech. Bull. 25:204 (Holotype, male; Bear Canyon, Catalina Mts., Arizona; U.S. Nat. Mus.).

Pseudothysanoes gambetti Blackman, 1928, New York Coll. For., Syracuse, Tech. Bull. 25:205 (Holotype, male; Peloncillo Reserve, New Mexico; U.S. Nat. Mus.). *New synonymy.*

Pseudothysanoes barberi Blackman, 1928, New York Coll. For., Syracuse, Tech. Bull. 25:206 (Holotype, male; Williams, Arizona; U.S. Nat. Mus.). *New synonymy.*

The type series, including holotypes, of *sedulus* Blackman, *gambetti* Blackman, and *barberi* Blackman, and additional material totaling 155 specimens were compared directly. Blackman's names were

based only upon individual variations in short series that do not characterize species. For this reason *gambetti* and *barberi* are here placed in synonymy under *sedulus*, based on page priority.

Scolytodes glabrescens, n. n.

Prionosceles glaber Wood, 1961 (nec Eichhoff, 1867), Gt. Basin Nat. 21:102 (Holotype, male; Summit, Canal Zone, Panama; U.S. Nat. Mus.). *Preoccupied.*

Because of the transfer of *Hexacolus glaber* Eichhoff (1867, Berliner Ent. Zeitschr. 11:400) and of *Prionosceles glaber* Wood to *Scolytodes* Ferrari, resulting from action reported above, the latter species became a junior homonym and must be replaced. The new name *Scolytodes glabrescens* is proposed to replace the preoccupied name *Scolytodes glaber* (Wood).

Scolytodes glaberrimus, n. n.

Scolytodes glaber Eggers, 1943 (nec Eichhoff, 1867), Mitt. Münchner Ent. Ges. 33:360 (Male and female syntypes; Cochabamba, Bolivia; Paris Mus.). *Preoccupied.*

The transfer of *Hexacolus glaber* Eichhoff, cited above, to *Scolytodes* Ferrari, resulting from action reported above, made a junior homonym of *Scolytodes glaber* Eggers and a new name is required. The new name *Scolytodes glaberrimus* is proposed to replace it.

THE LETHAL DECLINE OF MESQUITE ON THE CASA GRANDE NATIONAL MONUMENT

B. Ira Judd,[1] James M. Laughlin,[1] Herbert R. Guenther,[1] and Royal Handegarde[1]

A visitor's first impression of the Casa Grande National Monument is one of taking a trip back through time to the late 14th century when the Great House was occupied by hardy Pueblo people. From a 20th-century viewpoint, a visitor can identify with the hardships endured by these farming people in this harsh environment.[2]

As one begins to view this environment he sees a typical desert area encircled by irrigated agricultural land. Yet, something is strikingly different. The area is littered with large deformed stumps of dead mesquite trees (*Prosopis velutina* Woot.). It is commonly asserted that these trees died in the early 1940s because the water table dropped due to increased irrigational demands. But no one truly knows just what caused the death of these trees.

This study is an attempt to determine what factor or factors may have been responsible for the massive lethal decline of the mesquite trees.

Casa Grande National Monument is situated 1.5 miles south of the Gila River and approximately 50 miles west of its junction with the Salt River. Located on an old floodplain, the monument comprises 480 acres of land 2 miles north of Coolidge, Pinal County, Arizona.

The area became a national monument in 1918. It was fenced on the north and east in 1931 and along the south and west boundaries in 1934. This restricted the trespass of people, livestock, and wildlife. To this day, the monument remains completely fenced and protected against all unauthorized trespass.

Dead mesquite trees are the rule throughout the area, with the exception of a few live ones in depressed locations.

The authors wish to acknowledge Superintendent Richard T. Hart, Casa Grande National Monument, for his kind assistance and permission to reproduce the photographs for Fig. 3 and 4; and Doctors Duncan T. Patten and D. J. Pinkava, Botany Department, Arizona State University, for their assistance.

Methods

In an endeavor to determine the age and year of death, 10 cross-sectional specimens were cut from various mesquite trees on the monument. These specimens were then sanded and polished to a high sheen and viewed under a variable 7-75 power stereoscopic

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[2]For a complete history of the Casa Grande Ruins and National Monument see Kiva, February 1962, Vol. 27, No. 3.

microscope. An attempt was made to count and measure the annual radial growth rings along a radius of each specimen.

Of the ten specimens cut, three proved to be satisfactory dendrochronological material. The data obtained from these specimens were plotted as a line graph, using years and width of annual rings as axes (Fig. 1).

The data obtained from the dendrochronological specimens indicate the age of these trees to be 137, 110, and 111 years respectively. All three specimens exhibited series of alternate good and bad growth years. However, attempts to correlate these with precipitation data or to crossdate between specimens proved ineffective. This may have been due to the accidental inclusion of false growth rings with the valid annual rings. Mesquite tree sections are extremely difficult to work with because of the diffuse porous nature of the wood and the faint lines of compressed terminal tissue found at the end of each growing season (Ferguson and Wright, 1962).

In a personal interview with Dr. C. W. Ferguson of the Tree Ring Laboratory, Tucson, Arizona, the dendrochronological methods used in this study were validated. Dr. Ferguson observed the specimens involved and found the age determination of the trees valid within reasonable accuracy.

Climate

U.S. Weather Bureau summaries and monument reports were surveyed for data involving precipitation and temperature. Heaviest

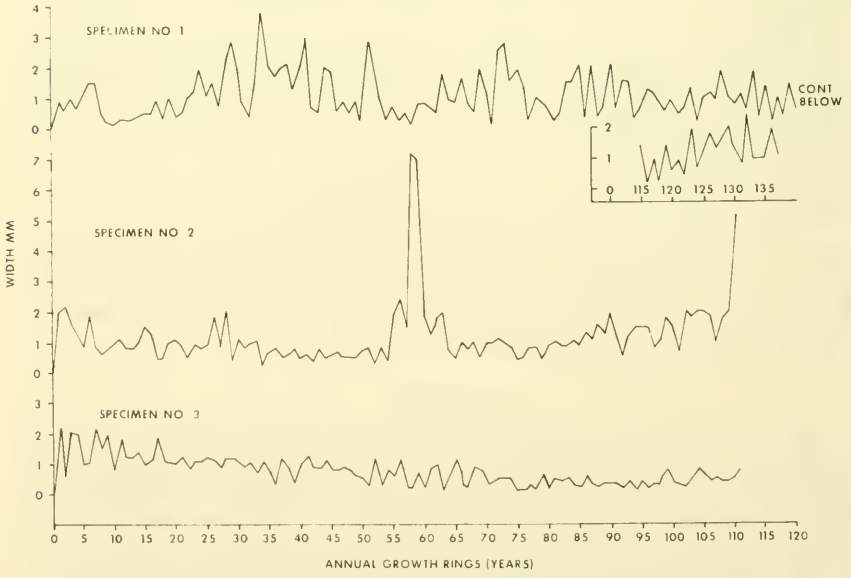

Fig. 1. Width (in mm) of annual growth rings by years for the three specimens studied.

precipitation usually falls during July and August when moist tropical air from the Gulf of Mexico covers the state. Thunderstorms are common in evenings at the monument during these months. The monument also receives some precipitation during the winter when middle latitude storms move far enough south to affect central Arizona. Annual precipitation totals ranged from a high of 19.22 inches in 1941 to a low of 3.56 inches in 1956. Other high precipitation years include 16.08 inches in 1914, 13.17 inches in 1912, 12.11 inches in 1915, 10.29 inches in 1936, and 10.01 inches in 1932. Low precipitation years include 4.63 inches in 1939, 5.84 inches in 1943, 6.14 inches in 1935, and 6.95 inches in 1938 (Fig. 2). The station at the monument was closed from August 1916 to August 1931, and no data are available for those years (Institute of Atmospheric Physics, University of Arizona, 1960).

Average yearly temperatures at the monument varied from 66.8 F to 71.6 F during the period from 1909 through 1959 except for the years 1916 to 1930, when the station was closed (Institute of Atmospheric Physics, University of Arizona, 1960).

Infestations

Possible natural enemies of mesquite were researched along with monument records and photographs. These included insects, parasites, and diseases common to mesquite in central and southern Arizona.

No evidence of infestation by insects or disease prior to the death of the trees was found. The only diseases reported to occur in mesquite in Arizona are leaf rust (*Revenelia arizonica* Ell. and Ev.) and leaf blight (*Sclerophysnium aureum* Heald and Lewis).

The mistletoe infestation was first officially noted in 1936, but the photographs of 1878 and 1930 (Fig. 3 and 4) show heavy infestation. Mistletoe is parasitic, sapping nutrients and valuable water from the host. This parasitism may have severely weakened the mesquite trees, prohibiting their adaptation to a changing environment.

The following excerpts taken from the Southwestern Monuments Monthly Reports, referring to a mistletoe infestation of the mesquite trees on the monument, indicate the awareness of the parasite:

> An infestation has been noticed on some of our mesquite trees. The Naturalist Division informs me that it is not unusual and should be investigated by a forester. Is such an expert available? (SWM, January 1936)
>
> Mr. Yeager inspected the mesquite infestation and told us that it needed considerable attention. It will need additional funds to cope with the situation, the urgency of which I cannot overemphasize. The infestation is spreading rapidly and will result in the loss of all of our mesquite trees if remedial measures are not taken very soon. Mr. Yeager will return with another expert on the 29th and we can then determine just how much money will be needed. I hope that you can make the Great White Father see the necessity for immediate action. (SWM, September 1936)

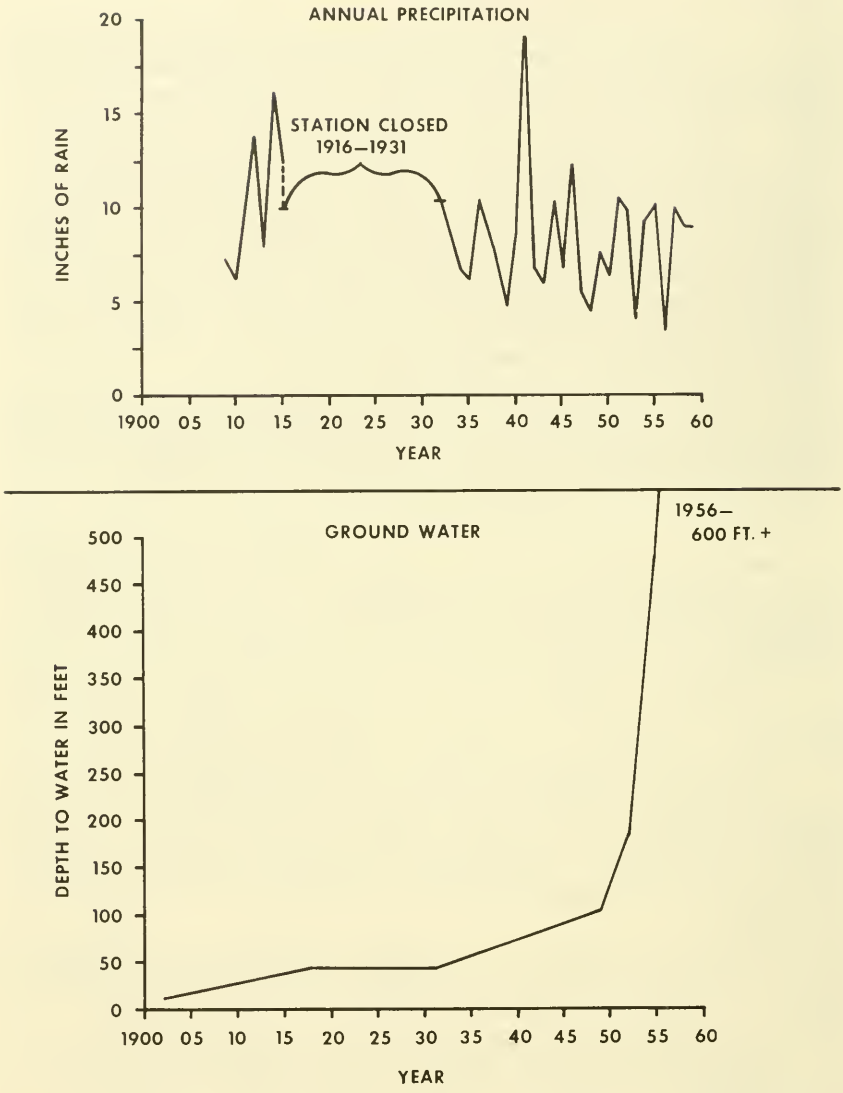

Fig. 2. Annual precipitation and depth of groundwater by years at Casa Grande National Monument.

Naturalist Natt Dodge notes:

When I came to Casa Grande National Monument in the fall of 1937, Monument personnel told visitors who asked that the mesquites were dying because of a lowering of the underground water table. This was borne out of the Monument water well going dry and having to be

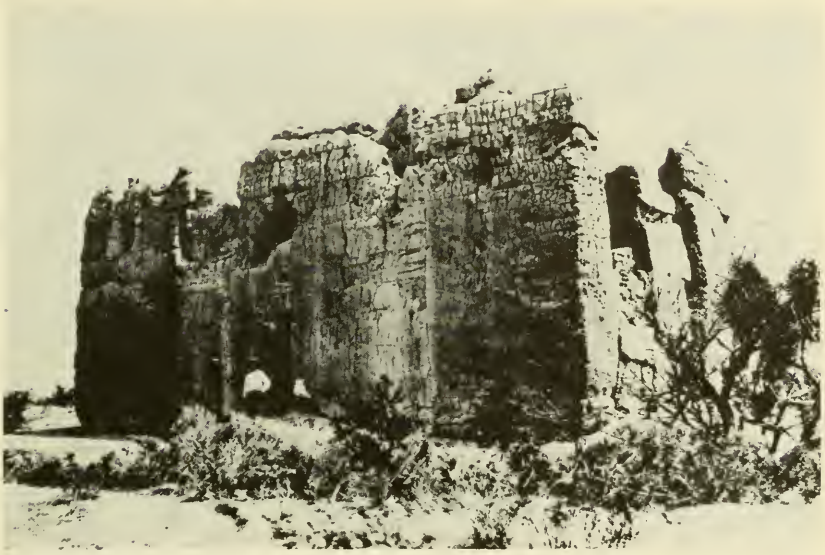

FIG. 3. Appearance of Casa Grande Ruins in 1878. (Dark growth on trees is mistletoe.) (Courtesy National Park Service.)

deepened. However, an infestation of mistletoe was believed to be partially responsible.

GROUNDWATER

Available recorded water table data of the Arizona State Land Department, U.S. Geological Survey, and Casa Grande National Monument were researched and compared. In addition, a local well driller was interviewed about current conditions and substrate material.

The groundwater table adjacent to the Casa Grande National Monument declined from a depth of 44 ft in 1923 to approximately 100 ft in 1952 and approximately 150 ft by 1960 (U.S. Geological Survey data, Fig. 2). The monument is located in sections 9 and 16 of township 5 south, range 8 east, and the well site mentioned above is on section 17 of township 5 south, range 8 east, of the Gila and Salt River Meridian.

According to monument well records, the water table data are as follows:

1902 - First well dug on area; water standing at 10-16 ft (Monthly Report, September 1918).

1918 - New well dug; water level reached at 42′6″ (Monthly Report, October 1918).

1931 - Well drilled on area; water level 42′6″ from surface, 186′5″ pipe in hole (Log of well, old file no. 660-05.8).

FIG. 4. Aerial photograph, 1930, showing Casa Grande in relation to adjacent prehistoric ruins. (Courtesy National Park Service.)

1949 - Depth to water in monument well, 102′ (Letter to Hayden from director, 16 February 1956).

1952 - Water in well at depth of 180′ yielding 14 gallons per minute. Reservoir insufficient to supply needs of monument. Water piped to area from town of Coolidge (Letter of Hayden from director, 16 February 1956).

Mr. Dale Blakeman, a local well driller in Coolidge, Arizona, drilled a new well adjacent to the monument (1969). He reported that as he drilled, he passed through 30 ft of alluvial fill followed by 100 ft of large, rounded river boulders and a clay shale composite thereafter. He found no water at 130 ft plus.

Water table data tend to support the theory that it was a factor leading to the death of the mesquite trees. Root system development of mesquite trees varies. On deep soils with adequate moisture, a strong tap root tends to develop. But, on upland slopes where soils are more shallow and moisture seldom penetrates deeply, the tap root is small and lateral roots may reach out in all directions for 50 ft or more just beneath the surface (Parker and Martin, 1952). Phillips (1963) reports finding mesquite roots growing 175 ft below the ground surface.

The ability of mesquite to modify its root system is unknown. However, when the water table on the monument dropped 34 ft from 1902 to 1923, the mesquites were able to survive. It is possible that the maximum limits of extension or modification of the root system had been reached. Between 1931 and 1949 the water table

declined another 60 ft and the trees died. Possibly, the roots could not penetrate the extremely thick layer of boulders that Mr. Blakeman referred to; or it may be that the boulders could not retain enough moisture to support the advancing roots.

Discussion

Incomplete data and records were a constant source of problems during this study. It appeared as though persons recording data or observations took much for granted.

With the severe climate at the monument, all environmental factors become more critical. A few dry years could add considerable stress to a weakened tree. Insects, usually taking advantage of disadvantaged individuals, could find the mesquite trees ideal forage material, further compounding the problem. In addition, opportunistic leaf and root diseases could take advantage.

The cause of the lethal decline of mesquite trees on the monument appears to involve a number of factors, each contributing to the end result. Decline of the water table and mistletoe infestation may be the major contributors with age of trees, insect infestation, and natural successional process as secondary factors.

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NEW RECORDS OF LACE BUGS FROM NEVADA (HEMIPTERA: TINGIDAE)

Richard C. Froeschner[1]

A small collection of Nevada lace bugs submitted by Dr. Robert C. Bechtel for identification contained several state and host records not included in the Drake and Ruhoff (1965) catalog nor the Beck and Allred (1966) list. Details of this collection are here recorded to make the new data available for other studies, including my manual of lace bugs now in preparation. State and host records listed in neither of the above papers are indicated by an asterisk following the organism's name. All localities, except Hinkey Summit and Mahogany Mountain, are in Clark County; these two exceptions are in Humboldt County.

*Corythucha eriodictyonae** Osborn and Drake. Mt. Springs Summit, 19 May 1960, R. C. Bechtel; numerous nymphs and adults from *Eriodictyon angustifolium.**

*Corythucha morrilli** Osborn and Drake. Overton, 13 July 1960, R. C. Bechtel; nymphs and adults abundant on *Helianthus annuus.* Bunkerville, 21 July 1962, R. C. Bechtel; nymphs and adults on *Helianthus annuus,* and on *Baccharis* species. Las Vegas, 25 November 1962, D. F. Zoller; adults and nymphs on *Artemisia arbortanum.**

*Corythucha salicata** Gibson. Hinkey Summit, 8,050 feet, 11 July 1963, R. C. Bechtel; numerous adults from *Populus tremuloides.**

Corythucha sphaeralceae Drake. Nelson, 16 April 1966, F. A. Hilbig. Logandale, 26 September 1968, R. C. Bechtel; nymphs and adults from cultivated squash,* adults only from *Althaea rosea.**

Gargaphia opacula Uhler. Mahogany Mountain, 15 July 1970, R. C. Bechtel and P. C. Martinelli; adults, eggs, and newly hatched nymphs on underside of foliage of *Cercocarpus ledifolius.**

*Leptoypha minor** McAtee. Pine Creek, 4 June 1962, R. C. Bechtel; adults and nymphs on *Fraxinus velutina.*

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ECOLOGICAL NOTES ON RECENTLY DESCRIBED MYRIAPODS FROM NEVADA[1]

Dorald M. Allred[2]

During 1959 the Department of Zoology of Brigham Young University, under contract with the U.S. Atomic Energy Commission, initiated ecological studies at the Nevada Test Site (Allred, Beck, and Jorgensen, 1965). The chilopods and millipeds collected in can pit-traps from 1959-1962 (Allred, Beck, and Jorgensen, 1963a) were submitted to Dr. Ralph V. Chamberlin for identification. Most of these represented species new to science and subsequently were described by him (Chamberlin, 1962a, 1962b, 1963, 1965). He intended to publish complete data for all the specimens taken from the test site, but was unable to do so before his death in 1967. This paper provides the ecological distribution and seasonal occurrence of the myriapods identified by Chamberlin, and furnishes additional data on the species which he described as new from the test site.

Chilopoda

Abatorus allredi Chamb.

Chamberlin (1965) diagnosed a new genus and described a new species from a male taken from "Nevada: Nye Co., Nevada Test Site," in 1961, and several specimens from "California: Riverside, Box Springs." The specific collection site in Nevada is in an area of mixed brush, 0.3 mile south of White Rock Spring (refer to Allred, Beck, and Jorgensen, 1963b, study area 12 C J).

Eremorus becki Chamb.

The type species of this new genus was described by Chamberlin (1963), with data listed as "Type locality: Nevada Test Area. Two specimens taken 6 March 1961." He identified three specimens from the site as referable to this species. Two were taken from a mixed brush habitat on 3 March 1961 near Cane Springs (collection code CBA 15; Allred et al., 1963b), and one from a *Grayia spinosa-Lycium andersonii* plant community on 6 March 1961 near test area ground zero 1 (collection code 1BF25; Allred et al., 1963b).

Gosibius arizonensis Chamb.

Twenty-three specimens of this species were taken at the test site. Collections are represented for each month except February, March, September, and October; and greatest numbers were found during November. Specimens were most abundant in the *Pinus monophylla-Juniperus osteosperma* plant community, with about half as many in mixed brush areas. Few were found associated with

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the *Grayia spinosa-Lycium andersonii* community, and none with other plant types. Animals were found at eight major study areas over the site, and most of those in the mixed brush areas were taken near Cane Springs

Nyctunguis stenus Chamb.

Chamberlin (1962b) described this species, apparently from two specimens submitted to him, with the type locality designated as "Nevada: Clark Co., Mercury, Nevada Test Area." These were taken from a *Pinus monophylla-Juniperus osteosperma* plant community on 28 November 1959, 0.5 mile south of the "Y" on the eastern edge of Rainier Mesa (collection code 12 CA; Allred et al., 1963b).

Oabius mercurialis Chamb.

This species was described by Chamberlin (1962b) from a female "taken Jan. 26, 1961" from a *Grayia spinosa-Lycium andersonii* plant community near ground zero 1 at the Nevada Test Site (collection code 1BB20; Allred et al., 1963b). "A second specimen taken Dec. 19, 1960" from the same habitat as the type was also used. Eleven other specimens were taken from six major study areas on the site from December through March, and in July. Specimens were most abundant in the *Pinus monophylla-Juniperus osteosperma* and mixed brush plant types, but were also found in *Salsola kali*, *Atriplex confertifolia-Kochia americana*, and *Grayia spinosa-Lycium andersonii* communities.

Scolopendra michelbacheri Verh.

Chamberlin (1962b) listed specimens of this species from "Nevada: Mercury, Clark Co., Nevada Test Area." A total of 49 were collected from 11 major study areas at the site. Most animals were taken during June and July, and were found during every month except January. These chilopods were most abundant in the *Grayia spinosa-Lycium andersonii* plant community and occurred in less abundance in mixed brush, *Larrea divaricata*, *Lycium pallidum*, *Coleogyne ramosissima*, and *Atriplex confertifolia-Kochia americana* areas.

Diplopoda

Arinolus nevadae Chamb.

This species was described by Chamberlin (1962a) from "Nevada: Mercury and adjacent area," with "many specimens taken mostly in October, November, and December 1960." A total of 112 specimens were collected from 11 major study areas at the site. Animals were taken from October through March, and in August. Most were taken during November, December, and February. These millipeds were most abundant in the *Lycium pallidum* and *Salsola kali* vegetative areas, with fewer numbers in mixed brush, *Artemisia tridentata*, *Grayia spinosa-Lycium andersonii*, *Larrea divaricata*, and *Coleogyne ramosissima* areas.

Arinolus sequens Chamb.

Chamberlin (1962a) described this species from a male taken 10 November 1960 in a *Coleogyne ramosissima* plant community in "Nevada: vicinity of Mercury." The specific locality is 9.5 miles north of Well 3B along Groom Lake road, thence 0.5 mile east (collection code 10 DA 1; Allred et al., 1963b).

Orthichelus michelbacheri (Verh.)

"Numerous specimens" were indicated by Chamberlin (1962a) from Nevada. Fifty were taken from eight major study areas at the test site between October and March. Most were taken during November. Greatest abundance occurred in the *Lycium pallidum* and mixed brush communities with fewer numbers in the *Grayia spinosa-Lycium andersonii*, *Coleogyne ramosissima*, and *Larrea divaricata* communities.

Titsona tida Chamb.

This species was described by Chamberlin (1962a) from two specimens taken 31 March 1960 from "Nevada: Nevada test area, vicinity of Mercury." The specific area is in a *Grayia spinosa-Lycium andersonii* plant community near ground zero 1 (collection codes 1 BF 4 and 1 BH 21; Allred et al., 1963b).

Summary

Chilopods of six species and millipeds of four species are known from the Nevada Test Site. Those of greatest abundance and most widespread ecologically are *Scolopendra michelbacheri* and *Arinolus nevadae*, respectively. Myriapods were most abundant in the *Pinus-Juniperus*, *Grayia-Lycium*, *Lycium*, and mixed brush plant communities. Greatest numbers were found during November from 1959 to 1962.

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SOLPUGIDS OF THE NATIONAL REACTOR TESTING STATION, IDAHO[1]

Dorald M. Allred[2] and Martin H. Muma[3]

Little has been published concerning the ecology of the arachnid order Solpugida in the United States. Most North-American species are known to be nocturnally active, diurnally burrowing, rapidly running, cursorial predatory arachnids (Muma, 1966, 1966a, 1966b, 1966c, and 1967); but information on their ecological requirements, habitat preferences, population dynamics, and seasonal abundance has been recorded only twice (Muma, 1963 and 1966d). In Nevada over a two-year period (1960-1962), approximately 1,000 specimens representing 28 species, 9 of them new, were collected in unbaited, dry, can pit-traps (Muma, 1963). The same technique used over a 15-month period (1966-1967) in Idaho yielded 71 specimens and 6 species, 2 of them undescribed. Although these latter data are not voluminous, they provide, for the first time, an opportunity to compare ecological relationships of North-American solpugids.

The National Reactor Testing Station is situated in southeastern Idaho, and its southeastern boundary is approximately 30 miles west of Idaho Falls. The station is situated on a level plain with an average elevation of 4,865 feet. This is part of the Snake River Plain section of the Columbia Plateau Province. The central and southern parts of the station are typified by basalt flows which are exposed or covered by only a few feet of soil. The northern section is primarily lake and eolian deposits, and near-surface basalt flows are less common. Annual precipitation averages less than 10 inches. The average annual temperature is 42 F, with extremes of 102 and minus 43. The vegetation is characteristic of the cool, northern desert shrub biome. The most conspicuous plant over most of the area is sagebrush, *Artemisia tridentata.* Other predominant plants are rabbitbrush, *Chrysothamnus* spp., and grasses. For other details referable to the station, study sites, vegetational complex, and techniques, refer to Allred (1968) and Atwood (1970).

Species Recorded

Eremobates septentrionis Muma, 1970.—Eight males, nine females, and two immature specimens were taken from eight study areas (1, 2, 3, 6, 7, 10, 11, 12) in June, July, and August. Most were collected in July. Members of this species occurred among several different plant communities but were most commonly found with *Chrysothamnus* and *Artemisia.*

This species is known from California, Colorado, Idaho, Nevada, Oregon, Utah, Washington, and Canada (Muma, 1970).

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Eremobates ctenidiellus Muma, 1951.—One female was taken in July from area 7, predominated by *Chrysothamnus* and *Artemisia* vegetation.

Occurrence of this species in Idaho was expected on the basis of records from California, Colorado, Nevada, Oregon, Utah, Washington, and Mexico (Muma, 1951, 1962, 1963, 1970).

Eremobates sp.—One female and an immature specimen were taken from areas 1 and 7 in September and August, respectively.

Hemerotrecha denticulata Muma, 1951.—Nine males, six females, and four immatures were taken from eight study areas (1, 2, 3, 6, 7, 10, 12) in April, May, September, and October; most were collected in September. Members of this species were most commonly found where *Chrysothamnus* and *Artemisia* were the predominant plants.

Muma (1951, 1963, 1970) listed records of this species from Colorado, Idaho, Nevada, and Utah, and (Muma, 1963) indicated that in southern Nevada it was most commonly collected from *Salsola* and *Grayia-Lycium* plant communities, and overwintered as adults.

Hemerotrecha n. sp. "a."—One male was taken in September from area 12, where the predominant plants were *Juniperus*, mixed shrubs, and grasses.

Eremochelis bidepressus (Muma), 1951.—Two males were taken in June and July from areas 6 and 7, typified by *Chrysothamnus*, *Artemisia*, and *Tetradymia*.

Muma (1951, 1962) recorded this species from northern and southern Nevada. In the latter area 55% of the collections were from the *Grayia-Lycium* plant association. This is a new record for Idaho.

Eremochelis n. sp. "i."—One male was taken in July from area 7, predominated by *Chrysothamnus* and *Artemisia*.

Eremochelis sp.—Five immatures were taken in July and August from area 7.

Unidentified.—Twenty-two juveniles were taken in June, July, August, and September from seven areas (1, 2, 6, 7, 8, 10, 11); most were taken in August.

Discussion

The occurrence of 6 species at the National Reactor Testing Station is not as spectacular as that of the 28 species reported by Muma (1963) for the Nevada Test Site. However, the geographic study area in Idaho was smaller (900 sq. mi. as compared to the Nevada site, 1300 sq. mi.), and its more northern location with correspondingly lower average temperatures might not be as favorable for solpugid reproduction and population development as the more southern, warmer regions. The vegetation complex and soil types were also different.

Solpugids were collected in the Idaho study area from April through October, with the largest populations in July, August, and September (Table 1). The greatest number of species was collected during July. Immature specimens were most abundant in July and August; adults, in July and September.

Eremobates septentrionis and *Hemerotrecha denticulata* were the most numerous and widespread of the solpugids collected at the Idaho site. Preferred habitats of these arachnids were in plant associations of *Chrysothamnus* and *Artemisia.* Fewer numbers were found when only one of these plants occurred in association with other types.

In plant communities where both *Chrysothamnus* and *Artemisia* were absent, essentially no solpugids were found. No apparent correlation was evident between total plant cover and species or individual numbers of solpugids (Table 2).

A comparison of these data with those previously published reveals the following facts. In southern Nevada, solpugids were collected the year around and attained peak populations in May, June, and July (Muma, 1963). On the other hand, *Eremobates durangonus* Roewer was most abundant during August and September in southeastern Arizona (Muma, 1966d). Since the Idaho populations attained peak levels at or nearly concurrently with these more southern populations, it would appear that the effects of lower temperatures may be offset by inherent biotic factors of the species involved.

Similar deductions are afforded by previously published plant community-solpugid data and those presented here. In southern Nevada, a closely related species to *E. septentrionis*, *Eremobates zinni* Muma, was associated almost exclusively with *Salsola* in the *Grayia-Lycium* community, and *H. denticulata* was common in either *Salsola* or *Grayia-Lycium* communities (Muma, 1963). Since the Idaho populations of these species occurred in either *Chrysothamnus*, *Artemisia*, or combined communities, it would seem that plant associations may not be critical to solpugid abundance but that the plants themselves may be ecological replacements in the different deserts.

Further studies of solpugid populations should be made to test the above conclusions and to investigate the effects of other ecological

TABLE 1. Seasonal occurrence of solpugids at the National Reactor Testing Station, Idaho.

Item	Month						
	Apr	May	Jun	Jul	Aug	Sep	Oct
No. species collected	1	1	2	4	2	3	1
Total no. individuals collected	3	2	4	27	18	14	3
Immatures			1	11	16	6	
Adults	3	2	3	16	2	8	3

TABLE 2. Predominant vegetation based on percentage ground cover, and number of species and individuals of solpugids found in each of 12 study areas at the National Reactor Testing Station, Idaho.

	Study area and percentage of total ground cover*	No. of solpugid	
		Species	Individuals
1	*Chrysothamnus* 38%, *Artemisia* 24%, grasses 15% (bare ground 5%)	2	12
2	*Artemisia* 50%, *Chrysothamnus* 15%, grasses 15%, *Eurotia* 10% (bare ground 3%)	2	7
3	*Elymus* 50%, grasses and forbs 35% (bare ground 15%)	2	2
4	Grasses 90% (bare ground nil)	0	0
5	*Juniperus* 40% (bare ground 59%)	0	0
6	*Chrysothamnus* 30%, *Tetradymia* 30%, *Artemisia* 20% (bare ground 10%)	3	10
7	*Chrysothamnus* 41%, *Artemisia* 30% (bare ground 16%)	4	21
8	*Artemisia* 30%, *Atriplex* 26% (bare ground 38%)	1	6
9	*Chenopodium* 40%, *Eurotia* 35% (bare ground 20%)	0	0
10	*Artemisia* 68% (bare ground 13%)	2	3
11	*Chrysothamnus* 30%, grasses 26%, *Tetradymia* 22% (bare ground 5%)	2	6
12	*Juniperus* 30%, *Chrysothamnus* 15%, *Eurotia* 15%, *Artemisia* 13%, grasses 10% (bare ground 10%)	3	5

*Only those plants constituting 10% or more of the total plant cover are listed.

factors such as prey density, humidity, and soil structure on solpugid abundance.

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THE YELLOW PERCH FISHERIES OF DEER CREEK RESERVOIR, UTAH, WITH NOTES ON PARASITISM BY *LIGULA INTESTINALIS*

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Deer Creek Reservoir is a major sport fisheries area in north central Utah. A deep, cold, and moderately productive reservoir, Deer Creek should provide a fine environment for fisheries development. However, fish management problems are complicated by an abundance of small, mature yellow perch (*Perca flavescens*). This study provides an analysis on the utilization and condition of Deer Creek perch.

The dam, located along the Provo River 16 km southwest of Heber, Utah, supplies culinary and irrigation water for 18 municipalities and communities of north central Utah. With a maximum surface of 2680 acres, the reservoir has a capacity of 152,564 acre feet of water.

As is typical of many temperate zone reservoirs, Deer Creek experiences spring and fall overturn and is chemically and thermally stratified during summer months. Dissolved oxygen content remains high (8-11 mg/l) in the epilimnion, and total hardness ranges from 170-222 mg/l.

At present the reservoir sustains a community of 10 species of fish (see Table 1). All but the rainbow trout and kokanee have natural reproduction in the reservoir habitat. Only the mountain whitefish, Utah sucker, and Utah chub were original inhabitants of this region of the Great Basin.

Methods

Data on perch utilization were gained through use of a creel census from 13 May to 15 September 1968. Interviews were taken three days a week, alternating days in order to effectively cover each day of the week. Boat and shore fishermen from all sections of the reservoir were included in the census.

Specimens were collected using four techniques: those supplied by creel census information, experimental gill net, shocking, and seine. This combination was used in order to reduce bias of any one method and to insure capture of smaller fish.

Standard and total length measurements were determined to the nearest millimeter for each specimen. Weight in grams was taken from a spring scale, adapted for field use. All fish scale samples were removed from the anterior right side, both above and below the lateral line. Cellulose acetate impressions were made from the scales and analyzed according to year class.

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TABLE 1. Common and scientific names for all species of fish collected from Deer Creek Reservoir, Utah, 1968.

Perca flavescens Mitchill (yellow perch)
Micropterus salmoides Lacepede (largemouth bass)
Onchorhynchus nerka Walbaum (kokanee salmon)
Cyprinus carpio Linnaeus (carp)
Lepomis cyanellus Rafinesque (green sunfish)
Gila atraris Girard (Utah chub)
Salmo trutta Linnaeus (brown trout)
Prososopium williamsoni Girard (mountain whitefish)
Catostimus ardens Jordan and Gilbert (Utah sucker)
Salmo gaindnerii Richardson (rainbow trout)

Perch stomachs were placed in individual cotton bags and stored in 10% formalin solution. A volumetric displacement analysis for food types was utilized and organismal recognition made under a dissecting microscope. The number of parasitic tapeworm larvae was recorded from the coelom of each fish.

RESULTS

Utilization by Fishermen

Since there is no bag or possession limit on yellow perch in Utah, the fisherman can, without penalty, catch and discard as many perch as he wishes. Procedures for discarding fish are well outlined by the reservoir managers; however, violation of the rules is common and has resulted in a considerable shore pollution problem.

Of the 5288 fishermen interviewed during the standard creel census, 13 May through 15 September, 699 (13.2%) utilized the perch for sport and food. The average hourly catch was 2.0 perch per fisherman. Although this would indicate good fishing, the smallness of the adult perch, averaging 173 mm (6.8 inches) in length, reflects a poor-quality fishery. Of all fish taken home by anglers during the summer of 1968, the yellow perch accounted for 39.4% of the total catch. This high percentage of the catch is due to a minority of the fishermen's (13.2%) taking full advantage of no limitations on bag or possession limits. It was estimated that 35,249 perch were caught and utilized by Deer Creek fishermen during the initial 18-week period.

A weekend creel census taken weekly from 16 September through 24 November shows that perch accounted for 55.9% of the total catch. This adds an additional harvest of 8240 yellow perch.

Weekly fluctuations in catch per hour and percentage of total catch were plotted for the standardized creel census of May through September. The poorest fishing existed in the latter part of May and the first half of July. The decrease in May can be explained by observations of spawning activity among the perch, and to an increase in trout landings owing to heavy plantings of rainbow trout

by the Utah State Department of Fish and Game. The July slump in perch fishing has not been explained.

Stomach Analysis

The percentage analysis of food types by mass in Table 2 is based on the contents found in 193 perch stomachs. Organisms in the stomach contents of 0- and 1-year-class fish were difficult to recognize. Most were empty; however, of the 0 class fish all recognizable material was zooplankton. A heavy dominance of zooplankton mixed with some algae was found in 1-year-class fish. Pycha, Lloyd, and Smith (1954) indicate that perch up to 40 mm in length feed almost exclusively on macroplankton if it is available. The most recent planktonic study on Deer Creek Reservoir (Merkley, 1966) shows that the macro zooplankters *Daphnia* and *Cyclopa* are abundant throughout the reservoir. McDonald (1962) examined the stomach contents of 37 perch from Deer Creek and found *Daphnia* as the dominant food item.

Much of the zooplankton recovered from all age groups of perch during the present study period were either *Daphnia* or *Cyclopa*. It appears that all perch utilize the heavy concentrations of zooplankton present in the reservoir. In addition, the older fish feed on a wider variety of food types and less on zooplankton. Of the mature 3- and 4-year-class fish, a substantial percentage of the diet by volume (16.1%) is fish and large invertebrate material. Few of the fish were recognizable to species; those that could be identified were all perch. This type of cannibalism is often a sign of overpopulation and stunting (Eschmeyer, 1936).

Age and Size

Age, total length, standard length, weight, and condition factors were recorded for 535 yellow perch during the summer of 1968. Table 3 gives the number of fish caught per year class for each collecting technique. Collections were made from all areas of the reservoir, and no attempt was made to compare one section of the reservoir with another. Perch tend to migrate considerable distances in a large reservoir (Hasler and Burdach, 1949), and it was felt that

TABLE 2. A volume percentage analysis of food types by mass for each year class of yellow perch collected during 1968, Deer Creek Reservoir, Utah.

Year Class	Zoo-Plankton	Algae	Fish	Insects	Molluscs	Unrecog-nizable
0	99.0	..	..	..	..	1.0
1	80.0	9.0	..	..	..	11.0
2	83.3	8.3	8.3	..	..	..
3	58.2	0.9	40.0	0.9	..	..
4	60.2	4.8	24.1	1.2	9.6	..

TABLE 3. The number and age of yellow perch caught by four collecting techniques, 1968.

Year Class	0	1	2	3	4	5	Unknown
Seine	29	1	3	7	5	1	0
Gill nets	0	0	17	198	88	2	7
Shocking	20	57	22	15	5	0	10
Hook and line	0	0	4	33	2	0	9
All methods	49	58	46	253	100	3	26

overlapping during the three months' collection period would make correlations meaningless. Seine and shocking techniques were necessary for collecting 0- and 1-year-class fish. Gill net and hook and line information were selected for the older and larger fish.

Although perch can live up to 10 years or more (Sigler and Miller, 1963), fish collected in this study did not exceed 5 years in age. But observations of large perch near the dam on 9 June and 11 June might indicate that older fish do exist in the reservoir. Several gill nets were set in this area but none of the larger fish were caught.

The mean for each parameter measured on the 535 individual perch is given by year class in Table 4.

The coefficient of condition, designated as K (Lagler, 1956) is based on the formula: $K = \frac{W\ 10^5}{L^3}$ where W = weight in grams and L = standard length in millimeters. Condition is a measure of the relative plumpness of a fish to its body form. The weights of 0-class fish were not taken and the condition factors were not computed. The two-year-old fish had a K factor of 2.20 and represented the year class in best condition. The 1-year-class fish were growing rapidly in length and the K-factor was generally low (1.76). Standard length, total length, and weight increased rapidly from year class 0 through 2. Increases within mature fish classes 2 through 5 were less significant.

TABLE 4. Means obtained for each year class as to length, weight, and coefficient of condition on 535 yellow perch, 1968.

Age	Mean St. Length	Mean Total Length	Mean Weight	Mean K Factor
0	49.4 mm	60.6 mm	..	..
1	85.6 mm	102.4 mm	11.7 g	1.76
2	134.2 mm	158.7 mm	54.8 g	2.20
3	173.0 mm	204.9 mm	109.6 g	2.11
4	181.4 mm	214.4 mm	117.9 g	1.97
5	185.6 mm	219.0 mm	121.7 g	1.92

Wide variations in size occurred within each year class of the perch population. This is true for all parameters, including standard length and weight. Eschmeyer (1936) suggests that this is another characteristic of a stunted population. There is some evidence suggesting that a segment of the perch population may be spawning late in the fall. If true, this could account for some of the wide variations, particularly K-factors for the 1-year-class fish. Pitt (1955) found several Deer Creek perch in spawning condition in late September 1955. This same phenomena have been recorded for other species of fish found in western reservoirs. Johnson (1968) reported second spawnings by the threadfin shad in several Arizona reservoirs. On 11 September 1968, 24 yellow perch were dissected; each had well-developed gonads. This correlates closely with Pitt's observations in late September of 1955. Two additional trips were made later to look for egg deposits, but none were observed.

We believe that the heavy population of perch, some dual spawning, and the largeness of the reservoir habitat all contribute to the extreme variations in length, weight, and condition of the perch.

The size and age information taken during this study is particularly important when compared to a study by Pitt (1955) on Deer Creek Reservoir perch. Pitt took standard length, weight, and figured K-factors for 854 yellow perch. Although he did not collect fish of 0-year-class nor record weights for 1-year-class fish, correlations can be made on the other parameters for age classes 1 through 4 years. So few 5-year-class fish were collected during either study that valid conclusions cannot be made. It might be noted that Pitt found a limited number of 6-year-class fish during his study.

Comparing the combined age classes in 1955 with those of 1968, there has been a 14.6% increase in weight for those fish in the 1968 study. This increase was greatest in the 3- and 4-year-class fish. The larger size of the older fish might be due to increased predation on the perch by largemouth bass, whose population has increased substantially in the past 10 years (Lewellen, 1969). Bardoch (1949) reported that a similar situation in Lake Mendota, Wisconsin, was partially responsible for the improved fishing and increased size of the older yellow perch. Le Cren (1958) carried out a similar study on Lake Windermere, England, for 22 years. His conclusions were that heavy fish density has little or no effect upon growth of young, immature perch but that it is a major factor in contributing to stunting of size in the mature yellow perch. Since young fish are not affected by fish density, it is not surprising to note that the 1-year-class fish from 1955 are larger than those collected in 1968. A contributing factor for this difference is partially explained on the basis of parasitism changes on the perch population in the past 13 years (see Table 5).

Parasitism by *Ligula intestinalis*

To determine the effect of the pleuroceroid larva of the tapeworm *Ligula intestinalis* in yellow perch was the purpose of Pitt's

Table 5. Percentage of fish parasitized per year class, Deer Creek Reservoir, 1955 and 1968.

Age	1	2	3	4
1955[1]	1.3	7.2	19.0	25.6
1968[2]	37.7	13.6	2.8	3.2

[1]Pitt (1955).
[2]Present study.

Deer Creek study in 1955. A comparison of perch checked during the present study might be helpful in determining any changes in quality or quantity of parasitism since 1955.

Ligula intestinalis is distributed throughout the world and its life history is well known (Wardle and McLead, 1952). The adult tapeworms have been found in at least 40 species of birds and mammals (Dogiel and Petrushevsk, 1958).

Pitt (1955) found that the California gull, the most abundant waterfowl on Deer Creek Reservoir, was the major definitive host. The tapeworm eggs, found within the feces of gulls, are deposited in Deer Creek waters and there ingested by the invertebrate fauna. Copepods, such as *Cyclops strenuus,* ingest the eggs and are capable of providing the environment for development of the procercoid larvae (Dogiel and Petrushevsk, 1958). Not only are copepods abundant in Deer Creek Reservoir (Merkley, 1966), but they constitute a large percentage of the zooplankton found within the stomachs checked in the present study. When the fish feeds upon the copepod, the pleurocercoid larva is able to develop. The yellow perch has been shown to be an effective host by many studies, including Pitt (1955) and Wardle and McLead (1952). The cycle is continued when the gull feeds upon infected perch and the pleurocercoid larvae can develop into egg-laying adults.

A total of 248 perch of all age classes were inspected for occurrence of tapeworm larvae. A total of 14.5% of the fish examined were infected. Pitt's study showed an overall occurrence of 15.0%, nearly the same as the present study. However, changes in parasitism per year class may exist when comparing 1955 and 1968 data.

To compare studies it is necessary to eliminate year classes 0 and 5 for lack of information. It might be noted that parasitism, even though limited, did occur in the 0- and 5-year classes in the present study. Table 5 shows the percentage of parasitism per age class in the 1955 and 1968 perch. During the 1968 study the young fish, 1- and 2-year classes, were parasitized at a rate of 25.6%. The mature, 3- and 4-year-class fish were parasitized on an average of 3.0%. This difference could be due to variations in intermediate (copepod) host densities during the past few years. In reference to intermediate host densities, it has been shown by Dogiel and Petrushevsk (1958) that only about 2% of all procercoid larvae ingested by fish will develop into the pleurocercoid stage. Pitt's 1955 data show that 4.2% of the 1- and 2-year classes are parasitized,

while 22.3% of the 3- and 4-year classes are infected. He observed that the young fish in 1955 were feeding heavily on the abundant algae in the reservoir. It was during this period that algal growth was producing objectionable taste and odor in the water used for culinary purposes from Deer Creek Reservoir (Greenwood, per. comm.). Today the algal growth has been controlled and, as seen in the stomach analysis, all perch, particularly the young, were feeding primarily on copepods that were probable hosts of the larval tapeworms.

Many factors influence growth of fish, and parasitism, or the lack of it, is of primary concern. Pitt's study shows a possible reversal of parasitism (22.3%) on adult perch as compared to the present study (3.0%). The total effects on growth cannot be measured, but a comparison of 3-year-class fish for each study is helpful. The 3-year class is chosen because of the large number of fish examined for this age class. Unfortunately, the 3-year-class fish in the 1968 study only contained a few parasitized individuals. Comparisons are made in an attempt to show a trend and not to claim a high level of statistical significance. Pitt found that 19% of his 338 3-year-class perch were parasitized and that the year class as an average weighed 70.9 g and had a standard length of 147.5 mm. The author's 1968 studies show that 2.8% of the 253 perch were parasitized and the year class had an average weight of 109.7 g and standard length of 173.1 mm. Certainly reduced parasitism was a contributing factor to the increased size of the year class. This statement is further supported by comparing the mean size of mature fish parasitized to those of the same year class not parasitized. Considering the 3-year-class fish in the 1968 study, there was a 15.2% increase in standard length and a 39.5% increase in weight shown by the unparasitized fish.

Parasitized fish were collected from all areas of the reservoir. Pitt found the same pattern in 1955, basing his findings on the assumption that perch migrate in large bodies of water and that the intermediate (copepod) hosts were found everywhere. One area of the reservoir not investigated by Pitt was Wallsburg Bay. This is an area of small sheltered bays, and the perch collected there during 1968 were heavily infested with the pleurocercoid larvae of *L. intestinalis*. In all, 31.6% of the infected perch collected during 1968 came from this area.

Discussion

Evidence to suggest overcrowding and stunting was collected, but in comparing data from Pitt's study it is apparent that mature perch in 1968 were both larger and less frequently parasitized than those collected in 1955. Contributing factors, as to size differences, include a heavier predation on perch by the largemouth bass and to lack of tapeworm parasitism in adult perch.

Largemouth bass predation, having increased substantially since 1955, allows for less competition among surviving perch, thus resulting in increased individual growth. Unfortunately, the largemouth

bass is not ideally suited for the Deer Creek habitat and continued reliance upon it as a biological control is probably an unsound practice.

Lack of parasitism among adult perch in 1968 is thought to be correlated with decreased feeding upon probable intermediate hosts. The immature perch, who feed almost exclusively on probable copepod hosts, were found to be heavily parasitized. There seems to be little hope of eliminating the tapeworm problem. The definitive host, the California gull, is protected by state law, and the copepods are far too valuable as a food source to be irradicated.

As long as the perch remains small and abundant it will have a detrimental effect upon the sport fisheries of Deer Creek Reservoir. Present forces are far too slow in solving the problems. One possible solution would be the introduction of a new predator, one popular with fishermen and better suited to the Deer Creek habitat. The white bass (*Roccus crysops*) has been suggested by the authors, but present state fisheries programs include no measures for perch control.

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CONIFERS OF THE SAN FRANCISCO MOUNTAINS, SAN RAFAEL SWELL, AND ROAN PLATEAU[1]

Ronald M. Lanner[2] and Ronald Warnick[2]

This is the second in a series of notes on conifer distribution in The Great Basin and adjacent mountain areas. An earlier paper (Lanner, 1971) presented results of field surveys in selected parts of northern Utah. This article will cover three Utah areas further to the south, which represent diverse geological and environmental conditions. The occurrence of previously unrecorded species localities is supported by specimens deposited in the Intermountain Herbarium at Utah State University, Logan, Utah (UTC).

San Francisco Mountains

The San Francisco Mountains, a typical Great Basin fault-block range, are located in Beaver and Millard counties. The range is oriented roughly on a north-south axis and is about 18 miles in length. To the west across the Wah Wah Valley lie the massive Wah Wah Mountains. On the east is the Escalante Desert and the town of Milford. Elevations in the valleys approximate 5000 ft, and the San Francisco Mountains rise to a maximum of 9660 ft at Frisco Peak. The lower east slopes are comparatively gentle, and the west slopes are very steep.

Erdman (1970) reported Utah juniper (*Juniperus osteosperma* [Torr.] Little) and singleleaf pinyon (*Pinus monophylla* Torr. and Frem.) from this range. An early report by Butler (1913) mentioned supposed pinyon pines "two feet or more in diameter," from upper slopes used as timbers in the Horn silver mine. This suspicious report and the high elevation of Frisco Peak prompted a field trip in the summer of 1968. Access was facilitated by a newly completed road to electronic equipment at the summit.

In the rolling hills to about 7500 ft are thick stands of Utah juniper and singleleaf pinyon associated with sagebrush and rabbitbrush, as well as alder-leaf mountain mahogany (*Cercocarpus montanus* Raf.), as reported by Erdman (1970).

From about 7500 ft to the summit the slope steepens perceptibly, and a richer tree flora is found in sheltered places. White fir (*Abies concolor* [Gord. and Glend.] Lindl.) was found from 7500 ft nearly to the summit of Frisco Peak, scattered or in dense stands on east-facing slopes.

Ponderosa pine (*P. ponderosa* Laws.) was fairly abundant from 8500 ft almost to the summit. Some of these trees have diameters approaching 36 inches at breast height.

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Other species found in the same elevational zone with ponderosa pine were Utah juniper, Rocky Mountain juniper (*Juniperus scopulorum* Sarg.), singleleaf pinyon, and Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco). The latter species was restricted mainly to north aspects.

A dense stand of quaking aspen (*Populus tremuloides* Michx.) was encountered in a sheltered ravine facing the north at about 9000 ft.

From about 9300 ft to the summit, scattered specimens of bristlecone pine (*Pinus longaeva* D. K. Bailey) were found on southwestern exposures. These trees show fairly vigorous growth. Near the top of Frisco Peak they are associated with singleleaf pinyons, an unexpected species at so high an elevation.

San Rafael Swell

The San Rafael Swell is a rugged area of sandstone lying in Emery County, east of the Wasatch Plateau and west of the Green River Desert. It is about 60 miles in length on the north-south axis, and up to 40 miles from east to west. Much of the area consists of flat-topped mesas of sagebrush and grass deeply dissected by the San Rafael River and its tributaries. Floristically and topographically this area has much in common with the Canyonlands area. The southern part of the swell, including much of the "Sinbad Country" drains southward into Muddy Creek, a tributary of the Dirty Devil River, thence into the Colorado. Interstate Highway 70 now bisects the swell area. The highest point in the swell is San Rafael Knob, 7921 ft.

Utah juniper and pinyon (*P. edulis* Engelm.) are widely distributed throughout the area. Ponderosa pine is fairly common above 6700 ft on Cedar Mountain, where it is associated with aspen and Rocky Mountain juniper. A single ponderosa pine was spotted on Bottleneck Peak at about 6000 ft. Another ponderosa pine location was a ledge of a north-facing cliff about 2 miles southwest of the Blocks. Associated species were pinyon, Utah juniper, Douglas-fir and river birch(*Betula occidentalis* Hook.). Douglas-fir, which has not previously been reported from this area, was also found on north-facing slopes in Eagle Canyon, Devil's Canyon, and at the head of the south fork of Coal Wash (7200 ft).

Fremont poplar (*Populus fremontii* S. Wats.) is common along the San Rafael River and in washes and seeps throughout the swell. Singleleaf ash (*Fraxinus anomala* Torr.) was found in Buckhorn Wash.

Roan Plateau

The Roan Plateau is a major topographic feature in Carbon, Uintah, Duchesne, and Grand counties, Utah; and Garfield and Rio Blanco counties, Colorado. It rises gradually southward from the Uintah Basin to elevations often exceeding 9000 ft. The south edge of the plateau is an S-shaped row of multilayered cliffs—the Book

Cliffs below and the Roan Cliffs above—winding from Helper, Utah, to Grand Junction, Colorado. This area of well over 10,000 square miles is unevenly bisected by the Green River as it transits Desolation Canyon. The smaller area west of the Green is commonly known as the West Tavaputs Plateau, and the larger eastern area as the East Tavaputs Plateau. Coverage of so extensive an area of land, where access is hindered by roads that are few and far between, is bound to be cursory. We summarize below observations of three field trips (totaling 18 man-days in the field) made in the summer of 1969.

Pinyon and Utah juniper are abundant between 6000 and 8000 ft throughout the area. Occasionally pinyon is found to 9000 ft. Some common associates of these species are Gambel oak (*Quercus gambelii* Nutt.), Douglas-fir, ponderosa pine, and Rocky Mountain juniper.

Douglas-fir is most common between 6500 and 9000 ft. It is more abundant on the East Tavaputs Plateau than on the West, and more common on slopes and in canyon bottoms than on the plateau tops.

Ponderosa pine is typically found in small scattered stands on rocky outcroppings, in steep canyons, or near seeps. The only stands found on the West Tavaputs Plateau were in the Coal Creek drainage north of Wellington at 6600 ft. Some locations on the East Tavaputs Plateau are near the heads of West Fork of Hill Creek and Florence Creek, and on Wagon Road Ridge. According to Ralph Miles, state forester at Heber, Utah, ponderosa pine is also found on the west-facing slope of Main Canyon, a tributary of Willow Creek (Sec. 16, T14S R22E). Some other ponderosa pine locations are Little Horse Canyon and East Canyon, which drain to the south. In a side canyon of the West Fork of Hill Creek, ponderosa pine was associated with Douglas-fir, aspen, subalpine fir (*Abies lasiocarpa* [Hook.] Nutt.), limber pine (*Pinus flexilis* James), and blue spruce (*Picea pungens* Engelm.).

Limber pine occurs in isolated groups between 8000 and 9500 ft. On the West Tavaputs Plateau it was found above Sheep Canyon. Typical locations on the East Tavaputs Plateau were on the plateau tops or on steep slopes above Horse Canyon, West Willow Creek, and West Fork of Hill Creek.

Subalpine fir is common on both sides of the Green River on steep slopes above 9000 ft. On the West Tavaputs Plateau it is abundant in canyons draining into Range Creek and the Green River. Typical locations on the East Tavaputs Plateau are around the heads of Florence Creek, West Willow Creek, and West Fork of Hill Creek. Subalpine fir is usually associated with Douglas-fir and aspen.

Blue spruce was found only along West Fork of Hill Creek, on the East Tavaputs Plateau, between 8000 and 8500 ft.

Discussion

Most of the observations recorded above augment the scanty knowledge of some rugged and inaccessible areas. Thus, six species

are recorded for the tree flora of the San Francisco Mountains for the first time (Rocky Mountain juniper, white fir, ponderosa pine, bristlecone pine, Douglas-fir, quaking aspen). Three species, previously unreported in the San Rafael Swell flora, are included (Rocky Mountain juniper, Douglas-fir, quaking aspen), and the range of others has been extended.

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ALBINISM IN *THOMOMYS TALPOIDES* FROM COLORADO

G. Keith LaVoie[1], Howard P. Tietjen[1], and Michael W. Fall[1]

Anomalies of pelage coloration among the various species of pocket gophers are not uncommon; however, most reported specimens are melanistic or exhibit only partial albinism. Bailey (1915) reported four specimens of the genus *Thomomys* that were apparently complete albinos. Six albino specimens of *T. bottae* from California collections were described by Storer and Gregory (1934). Bradley (1963) collected a completely albino *T. umbrinus* near Las Vegas, Nevada. Burnett (1925) described a *T. talpoides* trapped in Larimer County, Colorado; it "approached albinism," being a deep cream color. Mr. R. H. Brannaman of Larimer County, Colorado (1970), reported two white *T. talpoides* with black eyes in a sample of 954 trapped from his ranch in the past four years. To our knowledge, there is only one other report of a completely albino *T. talpoides*. Tryon (1947) found one in a sample of over 1000 gophers trapped in Montana.

On 6 November 1970, while live-trapping *T. talpoides*, we captured a completely albino male in Douglas County near Sedalia, Colorado. We estimated that more than 1000 gophers have been trapped for laboratory studies in this meadow and adjacent ranchlands since 1962. This specimen was a young-of-the-year weighing 75 g. The measurements were as follows: total length—165 mm, tail—40 mm, hind foot—26 mm, ear from notch—6 mm. The animal was completely white above and below, and hairs were uniformly white from base to tip. The eyes lacked pigment, being entirely pink. The specimen is preserved in the collection of the Denver Wildlife Research Center.

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FOOD PREFERENCES OF THE CLIFF CHIPMUNK, *EUTAMIAS DORSALIS*, IN NORTHERN UTAH

E. B. Hart[1]

Abstract.—Food consumption by the cliff chipmunk, *Eutamias dorsalis*, was observed in northern Utah in the natural habitat during May, June, July of 1965, 1966. Plant food sources nearest the cliff den sites were used in early spring, and as the season progressed, chipmunks increased ranges proportionately with the positioning of specific maturing food plants. Total daily frequencies of plant use suggested the following plants as prime energy sources in order of observed usage: *Tragopogon*, *Balsamorhiza*, *Poa*, *Lomatium*, *Bromus*, *Crepis*, *Amelanchier*, *Agoseris*.

The cliff chipmunk, *Eutamias dorsalis*, occurs in mountainous, rocky areas of parts of Utah, Nevada, Arizona, Colorado, Wyoming, New Mexico, and Mexico (Hall and Kelson, 1959). Its extreme wariness, coupled with habitation of partially inaccessible areas, probably accounts for the incomplete knowledge of its life history. This study was initially undertaken to relate chipmunk movement to environmental factors, especially food plants (Hart, 1967).

Materials and Methods

This investigation was conducted at a cliff located on the east side of Beirdneau Hollow, Logan Canyon, 7 miles east of Logan, Cache County, Utah. The face of the lower of two parallel perpendicular cliffs 35 m in height and the adjoining hollow to the south of this cliff were designated as the study center. The entire study area encompassed approximately 20 acres surrounding the lower cliff. Cliff chipmunk habitat consisted of precipitous cliffs which contained dens, and talus slopes interspersed with clumps of bigtooth maple (*Acer grandidentatum*), sagebrush (*Artemisia*), and juniper (*Juniperus utahensis*).

Snow cover normally persists from November to March or April; the frost-free season extends from May until late September or early October.

The study site was visited over 140 times, usually from 0600 to 1300 hr and from March through July 1965 and 1966; occasional trips were made in August, September, and October. Animals were captured in early May with modified Sherman live traps, toe clipped and dyed in individually identifiable patterns with black Nyanzol A dye (which persisted up to three or four months) and released. Seven-power binoculars were used to study animal movements and life history. During each visit areas were traversed below and above the cliff in order to observe foraging chipmunks.

Frequency of use of observed plant feedings was recorded for both marked and unmarked animals. Each sighting was scored

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singly as were observations of exploited plant remains deposited in typical chipmunk style. Plants of doubtful identity in the field were preserved for later comparison with reference materials. From the summary of daily-use frequencies, total observed utilization of each plant species was calculated. Temporal ranges were determined by grouping chipmunk movement patterns that corresponded to the time periods formed by the highest observed frequency of use of specific plants (Hart, 1967).

Results and Discussion

Exploitation of plants by cliff chipmunks appeared to be most intense in early spring in the area closest to the central cliff, where

Table. 1. Incidence of plant use by cliff chipmunks in Utah in 1966.

	May		June		July	
Plants	Observations	Percentage of Observed Feedings	Observations	Percentage of Observed Feedings	Observations	Percentage of Observed Feedings
Acer	15	26.8	3	1.14	1	.42
Achillea					1	.42
Agoseris			24	9.13	2	.85
Allium			1	.40		
Amelanchier	20	36.7	4	1.52	3	1.27
Artemesia	2	3.7	2	.80	2	.85
Balsamorhiza	6	10.7	66	25.10		
Bromus			26	10.00	10	4.24
Cirsium					17	7.20
Clarkia					1	.42
Collimia			1	.40		
Crepis	1	1.8	19	7.22	8	3.39
Hachelia			12	4.94		
Hesperochlea			2	.80		
Juniperus	2	3.7	3	1.14	3	1.27
Lichens	1	1.8	1	.40		
Linum			1	.40	2	.85
Lithospermum			1	.40		
Lomatium	1	1.8	32	12.20	13	5.41
Mertenisa	1	1.8	5	1.90	2	.85
Montia			1	.40		
Petrophytum	2	3.8				
Poa	2	3.8	32	12.20	18	7.62
Prunus					3	1.27
Purshia	1	1.8	1	.40	56	23.73
Symphoricarpos	1	1.8	4	1.52	5	2.12
Tragopogon			22	8.37	89	33.47
Viola	1	1.8				
Total	56		263		236	

the den sites were located. These foraging activities appeared to dominate overall activity of chipmunks, especially from just prior to sunrise to about 12-1300 hr.

Between the hours of 1200 to 1600, there appeared to be generally decreased activity, though occasional single animals would be encountered far from the cliff center in the middle afternoon hours. From 1600 to dusk, overall activity increased somewhat. The period of lessened afternoon activity may have been attributable to less central cliff activity due to previous radiation of animals into more favorable and productive peripheral feeding areas. Although the study site was visited in the afternoons and early evenings, sightings were never as consistent and numerous as during the early morning hours. Chipmunks underwent somewhat regular periods of sedentary activity in the afternoons; consequently, they were very difficult to locate, except by carefully traversing the area on foot. Positive identification was made difficult under these circumstances; rapid flight of startled animals frequently occurred, giving no prior indication of their presence.

As soon as the snow cover melted in late March and early April, chipmunks began to investigate many food sources and this activity continued throughout the summer. They dug in dead leaves, possibly for seeds, young roots, and/or insects; also, lichens and mosses were utilized substantially as the first herbaceous growth appeared.

As the season progressed, animals could be observed departing the central cliff, feeding as they moved out toward more abundant sources of preferred food plants 150 m (and further) up the mountain. Chipmunks seemed to establish general pathways over which they traveled daily and foraged systematically. One could almost invariably predict the location of familiar animals at given periods during the morning hours.

Activities of the cliff chipmunk related to the most preferred foods were as follows (Table 2):

Bigtooth maple (*Acer grandidentatum*) budded early in May and chipmunks fed on tender leaf buds. Trees located nearest the cliff edge were foraged upon first, and it was common to see several individuals feeding simultaneously in different parts of the same tree.

Exploitation of the serviceberry (*Amelanchier utahensis*) began around the middle of May. The chipmunks initially chose the budding, tender leaflets; later in the summer fruit was preferred. Serviceberry grew almost exclusively on or near the cliff rim. Thus, few chipmunks were observed more than 50 m from the cliff during maximum availability of *Amelanchier;* no caching of this plant was noted.

Arrowleafed balsamroot (*Balsamorhiza sagittata*) was a major source of food for the chipmunks. This plant species was widespread over the entire study area and was available much of the summer. Leaves, stems, and seed heads were consumed. Chipmunks typically cut the stem and deposited the seed hulls in a small pile. On occasions up to four individuals fed simultaneously on plants within 5 m of one another.

TABLE 2. Observed frequency of utilization of food plants by the cliff chipmunk in Utah during the summer of 1966.

Food Plants	No. of Feeding Observations	Percentage of Total Feeding Observations
Tragopogon dubius	111	20.0
Balsamorhiza sagittata	72	13.0
Purshia tridentata	58	10.4
Poa spp.	52	9.4
Lomatium dissectum	46	8.3
Bromus spp.	36	6.5
Crepis acuminata	28	5.5
Amelanchier utahensis	27	4.9
Agoseria glauca	26	4.7
Acer grandidentatum	19	3.4
Cirsium spp.	17	3.1
Hackelia spp.	12	2.2
Symphoricarpos oreophilus	10	1.8
Mertensia spp.	8	1.4
Juniperus utahensis	8	1.4
Artemesia spp.	6	1.1
Linum lewsii	3	0.5
Prunus virginiana	3	0.5
Petrophytum caespitosum	2	0.4
Hesperochlea kingii	2	0.4
Lichens	2	0.4
Viola vallicola	1	0.2
Allium campanulatum	1	0.2
Lithospermum spp.	1	0.2
Collomia parviflora	1	0.2
Montia perfoliata	1	0.2
Clarkia rhomboidea	1	0.2
Achillea spp.	1	0.2
Total	556	100.0

Bluegrass (*Poa fenderliana* and *P. secunda*) and wild carrot (*Lomatium disectum*) grew mostly within 150 m of the cliff, and maturation of the three plants corresponded closely. These were found to be utilized in almost equal quantities. Chipmunks preferred stems and seeds of *Lomatium* and the seeds of *Poa*.

Salsify (*Tragopogon dubius*) matured in late June and July. This plant was selected for both the seed head and leaves. Dissected seed heads were found frequently throughout the plot as chipmunks commenced feeding.

Bitterbrush (*Purshia tridentata*) matured in June and was eaten continually thereafter. *Purshia* shrubs were located in three main areas of the study area as follows: immediately below the central cliff, about 150 m above the rim, and near a high rocky outcrop 250 m higher than and southeast of the cliff rim. As *Purshia* seeds matured, chipmunks were seen to feed on the shrubs closest to the study center at least four days before they were seen to exploit the more peripheral sources (250 m). Seeds were often stored by chipmunks. These were transported rapidly from the distant rocky outcrop to caching areas closer to the cliffs; travel routes inevitably followed talus slopes. One chipmunk (F2-9) made three trips, covering a total of about 1500 m in approximately four hours.

Elk thistle (*Cirsium foliosium* and *Cirsium vulgare*) matured in late July. The prickly plant parts did not seem to deter the chipmunks from consuming seed heads. *Cirsium* plants grew singly and were not numerous above or below the cliff.

Cliff chipmunks appeared to be opportunists; they utilized the species of mature plants available. This food was supplemented by other less abundant, but continually available, edible plants such as the mountain dandelion (*Agoseris*), brome grass (*Bromus*), and long-leaved hawksbeard (*Crepis*). These latter plants appeared to remain in edible condition considerably longer than did other "major" food plants. Chipmunks foraged upon the leaves and seeds of *Crepis;* on the leaves, blossoms, and seed heads of *Agoseris;* and on the seeds and stems of *Bromus*.

The cliff chipmunk apparently satisfies its moisture requirements from dew and succulent plant parts. No animals were observed traveling to the closest water supply, about 300 m below the central cliff area.

No evidence of animal predation by *E. dorsalis* was observed though invertebrate life was abundant in the Beirdneau Cliff region. None of the stomachs which were examined from the Green Canyon chipmunks contained recognizable animal remains. This is in contrast to what Aldous (1941) found in his late summer study of foods of *Eutamias minimus* and *Tamias striatus* in California in which he reported that up to 100% of stomach contents was animal, mostly insects.

A small population of potential competitors, the rock squirrel, *Spermophilus variegatus*, occupied the same area of the cliff and foraged on many similar foods. However, chipmunks and squirrels seemed to feed on different parts of similar food plants. Rock squirrels seemed to prefer primarily leaves, while the chipmunks consumed the fruit, seed head, and stems, similar to the feeding habits of the least chipmunk, *Eutamias minimus*, and the mantled ground squirrel, *Spermophilus lateralis*, in Colorado (Carleton 1966).

Cade (1963) stated that survival adaptation was oriented more to food storage than toward altering physiological processes in the genus *Eutamias*. Survival therefore favors those animals which possess superior food hoarding abilities. In *E. dorsalis*, food caching in sub-

sidiary areas apart from the home den apparently was important for winter survival.

Grinnell (1924) was uncertain whether the same or different chipmunks recovered caches; he assumed that in most cases the same individual retrieved them. He stated that olfaction is probably important in cache recovery.

"Shallow hibernating" chipmunks were observed to cache seeds singly or in small numbers in shallow excavations, 2 to 5 cm deep. These caches were observed in several locations around the cliff site and those pilfered or lost (if any) were probably insignificant. Especially in instances of range overlap, individual recognition of food caches is important. Displaced and forgotten caches may become sources of reforestation, of possible value in maintenance of mountain watersheds.

Most caches which I observed were located between source plants and den. Two chipmunks (No. 5-10 and F2-9) had caches located 100 m and 150 m, respectively, above the cliff dens. The use of temporary storage areas allowed chipmunks to devote most of their time to securing abundant natural seeds during optimal harvesting conditions. Caches were presumed to be later transported to winter residences. Chipmunk F2-9 cached 14 *Purshia* seeds on 30 July; the cache was still intact on 7 August, but all seeds were gone on 2 September.

In the Beirdneau habitat, chipmunk survival was probably not dependent on midwinter seed recovery from frozen ground under a snow cover of 0.5 to 2 m in depth, but rather on autumn retrieval. Little or no hoarding of food items was observed during March, April, or May, but mature and relatively nonperishable seeds were stored from June through October.

Of the more than 80 plant species available in the study area, chipmunks definitely utilized 28 during the summers of 1965 and 1966 (Table 2). Chipmunks' food preferences were exhibited according to plant phenology and availability. This was especially evident as various edible plants matured and were almost immediately foraged upon by chipmunks.

Martinsen (1968) and Broadbooks (1970) found, similar to Utah cliff chipmunk behavior, that chipmunk movements were decisively influenced by distribution, abundance, and phenology of food plants in Montana and Washington.

In 1966 the occurrence of warm weather was about 10 days later compared to 1965. Nevertheless, the identical plant locations were visited by many of the same animals from 7 to 10 days later than the previous year; this would seem to correlate plant phenology and chipmunk feeding activity.

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identification. Mr. Jeff Black and Dr. J. K. Greer reviewed the manuscript. LuAnn Hart assisted with manuscript preparation.

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ILEX RUSHFORTHII, A NEW NAME

James L. Reveal[1]

In a review of the fossil flora of the Dakota Sandstone Formation near Westwater, Grand County, Utah, Rushforth (1971) described a new fossil species of *Ilex* (Aquifoliaceae) as *I. serrata*. Unfortunately, this name is already occupied and a new name must be proposed:

> *Ilex rushforthii* Reveal, nom. nov., based on *I. serrata* Rushforth, Brigham Young Univ. Sci. Bull., Biol. Ser. 14(3):38, figs. 12-5, 16-2. 1971, non *I. serrata* Thunb., Fl. Jap. 78. 1784.

Ilex serrata Thunb. is a variable, much-branched dioecious shrub that is commonly found in much of Japan and is frequently cultivated in the United States.

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BURROWING HABITS OF TWO SUBSPECIES OF *DIPODOMYS MERRIAMI* IN CALIFORNIA AND UTAH

Gerhard K. Bienek[1] and Albert W. Grundmann[1]

In connection with a study on the parasitic burden of *Dipodomys merriami merriami* Mearns and *Dipodomys merriami vulcani* Benson, the burrowing and nesting habits of the species were observed. Sites of the study were Panamint Valley, California, and Dixie State Park, Utah. The latter locality is in the most northerly extension of the range of the species in Utah (Burt and Grossenheider, 1964:155).

In 1964, Anderson and Allred reported that burrows of *D. microps* at the Nevada Nuclear Test Site rarely exceeded 50 cm, whereas burrows in Panamint Valley reached a maximum depth of 140 cm and burrows in Dixie State Park, a maximum depth of 163 cm. This discrepancy is probably due to the fact that Anderson and Allred studied an entirely different environment where the soil profiles showed caliche, which prevents penetration of the animals deeper into the soil. In those parts of Panamint Valley and Dixie State Park that were studied, however, no hardpan layer existed.

Only actual burrows, not subsidiary burrows, were examined intensively in the study of Panamint Valley and Dixie State Park, because subsidiary burrows are used exclusively for escape. Subsidiary burrows showed a depth of between 30 to 48 cm in both locations.

In April 1971, three burrows were excavated in Panamint Valley, California, in a *Prosopis-Atriplex* community. Burrows of *D. m. merriami* were located under mesquite in sand dunes, as described by Baker (1956). No rocks, herbs, or grasses were found in the immediate vicinity. Two burrows of *D. m. vulcani* were examined in May 1971 in Dixie State Park, Utah. These were found in a *Larrea-Franseria* community where volcanic rock strata alternated with sandstone. Grasses and herbs were present in this area. However, no rocks were found in the sand.

Since three of the burrows were located in old sand dunes, two shovels were used effectively to excavate the burrows. The tip of one shovel was placed into the opening, preventing the burrow from caving in, while the second shovel was used for sand removal.

The measurements of the Panamint Valley, California, burrows are as follows:

	Depth to Moist Soil	Length of Tunnel	Depth of Tunnel
Burrow No. 1	26 cm	520 cm	140 cm
Burrow No. 2	55 cm	300 cm	85 cm
Burrow No. 3	120 cm	330 cm	120 cm

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Burrow No. 1 reached a depth of 50 cm below the surface at a length of 320 cm. Thereafter, the grading was uniformly steep. Burrow No. 3 was located in an old sand dune.

Data for Dixie State Park, Utah, are as follows:

	Depth to Moist Soil	Length of Tunnel	Depth of Tunnel
Burrow No. 1	35 cm	260 cm	75 cm
Burrow No. 2	55 cm	365 cm	163 cm

All nests measured about 20 cm in diameter. They were very clean and contained pieces of chewed-up wood and some beetles. The nests in the Panamint Valley area also contained a few mesquite seeds; and the nests in the Dixie State Park location, seeds of Creosote and Franseria. Fecal droppings were found near the entrance of each nest. The humidity of the three nests studied in Panamint Valley was about 70% to 80%, and the soil temperature around the nests averaged 17 C.

Discussion

A close relationship exists between soil moisture, ground temperature, elevation, and the burrowing habits of *D. merriami*.

The burrows in Panamint Valley had a minimum depth of 85 cm and reached a maximum depth of 140 cm. In Dixie State Park, 75 cm was recorded as the minimum depth and 163 cm as maximum depth. Apparently, the level of the soil moisture played an important role in the depth of a burrow. Burrow No. 1 in Panamint Valley, for instance, was located in shallow sand where visible soil moisture began at a 26 cm depth, whereas burrow No. 3 in Panamint Valley was built in a very deep sand dune where visible soil moisture started at a depth of 120 cm. This suggests that the animals dig to a level of relatively permanent soil moisture to make their "nests." Anderson and Allred (1964) observed burrows of *D. microps* at the Nevada Test Site that reached a depth of about 50 cm. This probably is due to the fact that the elevation of Panamint Valley (elev., 325 m) and Dixie State Park (elev., 823 m) is lower than the study area at the Nevada Test Site, which ranges from 915 m to 1525 m elevation.

Since lower elevations have warmer temperatures, the animals seem to dig deeper into the soil to escape the heat. To support this hypothesis, some extreme surface and ground temperatures were measured at Panamint Valley.

Beginning of April 1971	ground temp., 21 C
Beginning of July 1971	constant ground temp., 29.5 C
Beginning of June 1971	maximum surface temp., 56.5 C.

Finally, it was observed that *D. merriami* collects a limited food supply in surface caches built in loose sand which were exposed

possibly by wind action. Surface caches were also mentioned by Reynolds (1958).

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The

Great Basin NATURALIST

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LIFE HISTORY ASPECTS OF THE TIGER SALAMANDER (*AMBYSTOMA TIGRINUM MAVORTIUM*) IN THE CHIHUAHUAN DESERT

Robert G. Webb[1] and William L. Roueche[1]

An isolated population of tiger salamanders (*Ambystoma tigrinum mavortium*) was most intensively studied from September 1962 through the spring of 1967, but periodic observations were made as late as the spring of 1969. Whitford and Sherman (1968), Whitford and Massey (1970), and one of us (Webb, 1969) previously discussed some information pertaining to this population of salamanders.

For financial assistance in the academic years 1962-1963 and 1963-1964 (grants to Webb), we are grateful to the University of Texas at El Paso University Research Institute. For aid in the field, we are indebted to James R. Dixon, Robert M. Kinniburgh, Jo Ann Brown, Artie L. Metcalf, R. Roy Johnson, H. Ellison Rodgers, Arthur J. Ward, Edward M. Stern, and Richard C. Lovelace. We are grateful to Richard D. Worthington for comments concerning the manuscript. All measurements refer to total length. Gehlbach (1967) summarized pertinent literature for the species.

Study Area and Habitat

Since permanent water is lacking in the area, cattle interests have necessitated the construction of numerous artificial ponds. Tiger salamanders were studied in one of these cattle tanks or ponds which, along with an adjacent windmill and large water-storage tank, is locally known as Taylor Well. It is located in an extensive north-south trending tract of the Chihuahuan Desert known as the Jornada del Muerto, and it is within the confines of the Jornada Experimental Range. Taylor Well, about 4,400 ft elevation, is approximately 19 miles north-northeast of Las Cruces, Doña Ana County, New Mexico, between the Doña Ana Mountains to the west and the San Andres Mountains to the east (Fig. 1). The average annual rainfall is about nine inches and the average annual temperature about 14.5 C.

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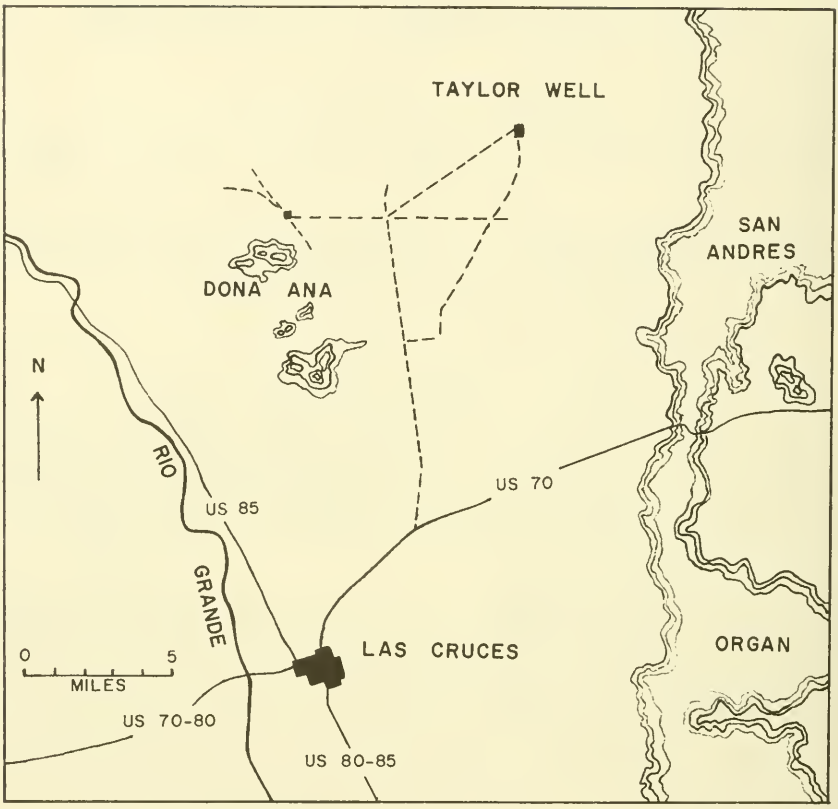

Fig. 1. Map of Las Cruces and vicinity, Doña Ana County, New Mexico, showing mountain ranges, Rio Grande, and location of Taylor Well; all dirt roads in area (dotted lines) not shown.

The desert terrain in the vicinity of Taylor Well is flat and supports a sparse, shrubby vegetational cover on loose sandy or hard-packed clay soils. Principal plants include creosote bush (*Larrea divaricata*), tarbush (*Flourensia cernua*), crucifixion thorn (*Koeberlinia spinosa*), mesquite (*Prosopis juliflora*), sumac (*Rhus microphylla*), tabosa grass (*Hilaria mutica*), and narrow-leaf yucca (*Yucca elata*); less prominent are lote bush (*Condalia lycioides*) and tumbleweed (*Salsola* sp.).

The pond at its maximum fill covers an area of approximately one and a half to two acres and in its deepest part is about five feet deep. Seapwillow (*Baccharis* sp.) and Bermuda grass (*Cynodon dactylon*) fringe parts of the pond (Fig. 1 in Webb, 1969). The water is turbid over a soft mud bottom. The green alga *Spirogyra*, the only aquatic plant, seems most abundant in the winter months when the water is deepest and coldest. Some aquatic invertebrates

include bloodworms (Tentapedidae larvae); damselfly and dragonfly naiads; adult bugs and beetles and larvae of the families Corixidae, Nepidae, Belostomatidae, Notonectidae, Dytiscidae, and Hydrophilidae; the gastropods *Physa virgata* and *Planorbella tenuis* (identified by Artie L. Metcalf, University of Texas at El Paso); and three phyllopods, two anostracans *Thamnocephalus platyurus* and *Streptocephalus texanus*, and one notostracan *Triops longicaudatus* (identified by Walter G. Moore, Loyola University, New Orleans). The anuran amphibians *Scaphiopus hammondi* and *Bufo debilis* breed in Taylor Well. Transient ducks occasionally visit Taylor Well; those identified include ruddy ducks, gadwalls, and pintails.

The water in the cattle stock pond at Taylor Well is temporary. In June and most of July the pond is usually dry; 9 April 1964 is the earliest and 3 September 1965 the latest date the pond was known to be dry. The period of dryness, however, is variable, and there may be shallow or occasionally deep water throughout the summer. Most rain falls in August and September, often in torrential downpours; however, a heavy rain filled the previously dry pond on 26 May 1964. Water exceeding three feet in depth occurred throughout the year in 1966, owing to torrential rains on 27-28 June and on 2 August.

Water (two to three inches below the surface) and air (shade, three to five feet above ground) temperatures were taken on different occasions. In water exceeding about two feet in depth, bottom temperatures were cooler than those at the surface. Ice about one-half inch thick covered the pond, except along the shoreline, on 10 December 1966 and on 18 January 1964.

Oviposition

Egg deposition ordinarily occurs twice each year—in the fall following the summer-fall rains that fill the pond and in the spring. In the summer the pond is usually dry. The timing and length of the breeding periods depend on the interaction of temperature and rainfall. Rainfall seems to be the prime factor that motivates breeding. Certainly rainfall stimulates breeding in the fall, following the hot summer months when the pond is usually dry. Spring rains also instigate breeding; in the spring of 1964, when the pond was dry in much of April and May, larvae were seined in June following heavy rains that filled the pond (Webb, 1969). The occurrence of gravid females was recorded on 7 March, 7 April, 15 April, 3 June, 9 June, and 1 December. The gravid female obtained on 1 December (both water and air temperature, 12 C) suggests breeding in cold months of winter (Hassinger, Anderson, and Dalrymple, 1970) or that eggs may be retained until spring. During mild winters, egg deposition may be uninterrupted from fall through spring. Eggs were found only twice in the fall—on the same date, 22 September, in 1966 and 1968; water occurred throughout the year in 1966, but torrential rains on 2 August probably stimulated breeding. In spring, eggs were discovered as early as 25 February 1968, and as late

as 19 April 1969; however, on both of these dates most embryos were in late stages of development, suggesting that oviposition occurred perhaps a week earlier in each month. Water temperatures recorded on eight occasions when eggs were discovered ranged from 12 to 22 (average, 18) C.

Eggs seem to be deposited on any submerged object. Eggs were most commonly found on scattered twigs and branches, especially on the submerged parts of tumbleweeds that blew into the water (Fig. 2); eggs were also found on cow droppings and the rungs of a barbed wire fence. Eggs were scattered in irregular fashion. A captive female wandered aimlessly and slowly through a tumbleweed bramble, stopping momentarily while depositing eggs; the period of egg deposition lasted about five hours. Eggs were usually deposited singly, often in pairs, and rarely in diffusely arrayed, mostly linear masses of three to nine eggs. Eggs in different stages of development may occur on the same twig or branch. The outermost gelatinous envelope is sticky and clear in recently deposited eggs but with subsequent development the envelope becomes brownish and cloudy owing to the adherence of suspended particles in the turbid pond water.

Fig. 2. Eggs (embryos) of *Ambystoma tigrinum* on tumbleweed (single egg and row of three in center); photograph taken 1 March 1969 by Richard C. Lovelace.

Eggs

Difficulties in interpretation and/or scrutiny of observation coupled with variation of some sort would allow for the discrepancy in the number and relative thickness of the investing egg envelopes or capsules of *Ambystoma tigrinum* to judge from a comparison of our eggs with those depicted in the illustrations by Storer (1925), Smith (1934), Bishop (1941), and Salthe (1963); a seemingly pertinent, but not readily accessible, paper (Wintrebert, 1912) was not consulted.

The fertilized egg, with the closely adpressed fertilization membrane, is surrounded by three gelatinous envelopes or capsules, designated inner, middle, and outer (Fig. 3). The animal pole is

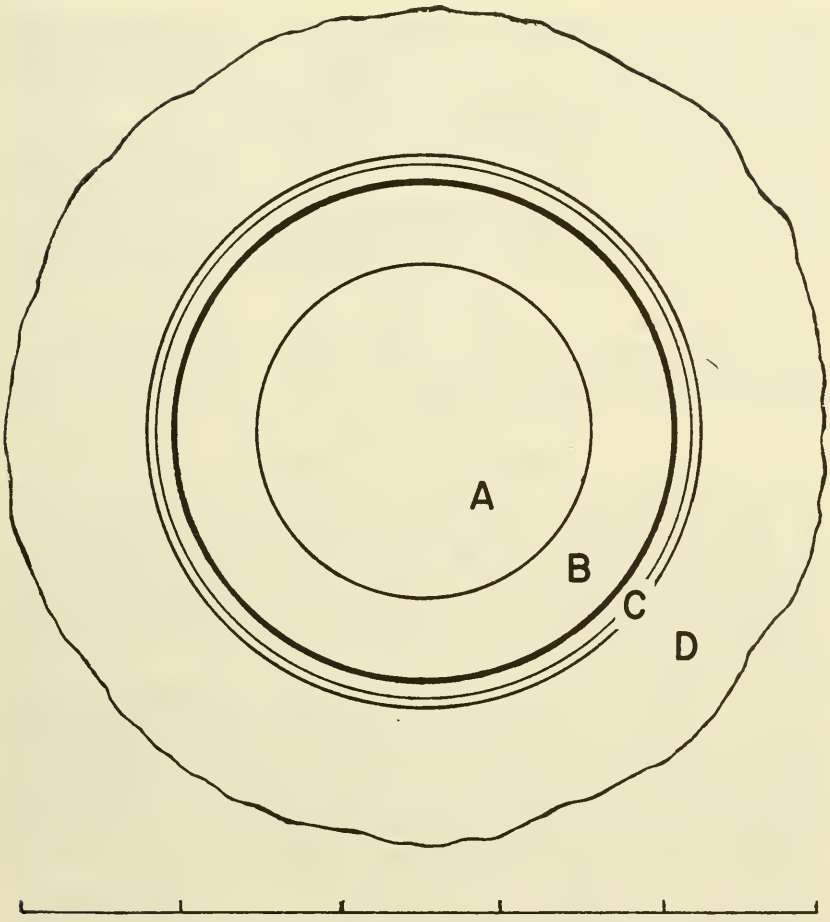

Fig. 3. Diagrammatic sketch of fertilized egg with gelatinous capsules or envelopes. *A*, vitellus (closely adpressed fertilization membrane and pigmentation not shown); *B*, fluid-filled capsular chamber with thin outer restraining capsule (heavy black border); *C*, middle double envelope; *D*, outer envelope. Line equals 5 mm.

pale brown or orange-brown, whereas the vegetal pole is whitish. The inner and middle envelopes are apparently double. The dissolved innermost part of the inner envelope forms a fluid-filled capsular chamber (Salthe, 1963) enclosing the floating egg or vitellus. The restraining boundary of the capsular chamber (enclosing capsular fluid) is a very thin, tough, and elastic capsule. In long preserved eggs (10 percent formalin), the capsular chamber with its outer restraining, thin capsule is often separated in places from the middle envelope. The middle envelope, relatively narrow, is also

tough and elastic and is composed of two layers of about equal thickness—an inner, semi-opaque, fibrillar layer and an outer clear layer. The outer envelope has an adhesive surface and forms the common gelatinous cover around two or more eggs.

Forty eggs, excluding envelopes, in various stages of early cleavage (measured to nearest 0.1 mm with ocular micrometer) ranged from 1.9 to 2.4 (average, 2.13) mm in diameter. The capsular chamber (with included vitellus and outer thin capsule) varied from 2.7 to 3.4 (average, 3.06) mm in diameter; the average width of this capsular chamber is about 0.50 mm. The middle (double) envelope (with included vitellus) ranged from 3.1 to 4.0 (average, 3.55) mm in diameter; the average width of this double envelope is about 0.25 mm. The outermost envelope is thickest and somewhat variable in width; in two or more eggs there seems to be no demarcation of this envelope around individual eggs.

Embryonic Development

The term "embryo" is applied to the nonfeeding individual from the time of fertilization until hatching, or when the individual is free of the gelatinous envelopes. To judge from observations of eggs laid by a captive female, most if not all newly deposited eggs show no signs of cleavage. Data are available on variation in time of development at different temperatures in the laboratory and in the pond at Taylor Well.

In the laboratory some embryos (eggs) were reared through hatching in pond water approximating 25 C. Observations of embryos preserved at various time intervals indicate the approximate time span between some developmental stages. The approximate time elapsed since deposition and the corresponding stage of development are: 12 hours—early cleavage, 24 hours—late cleavage, 90 hours—neural tube and tail bud stages, 156 hours—embryos wriggling periodically in envelopes, and 204 hours—hatching. After 156 hours, the wriggling embryos have three pairs of gills; the smallest embryos, about 6 mm long, lack gill fimbriae and have mostly white bodies with few melanophores, whereas the largest embryos, about 8 mm long, have gill fimbriae and prominent black peppering on the sides of the body. The smallest larvae at hatching measure 9 mm. The period of embryonic development is approximately 204 hours (8.5 days) at a temperature of 25 C.

Two sets of embryos (in different stages of development) were discovered at Taylor Well on 19 March 1966 (water temperature, 18 C). The least developed set (outermost envelopes transparent) was judged to be comprised of embryos in the period of cleavage, whereas the somewhat elongated embryos of the other set (partly visible through cloudy outermost envelopes) were near hatching. Embryos representing both developmental stages occurred close together in the same tumbleweed bramble. On 26 March (water temperature, 18 C), some embryos had hatched into larvae, as indicated by spent jelly envelopes. Almost all other embryos had cloudy outer

envelopes and were in late stages of development, suggesting that those observed on 19 March in the period of cleavage had developed to near hatching in the seven-day interval. These embryos were wrapped in cheesecloth to trap the larvae after hatching. Almost all embryos had hatched 11 days later on 6 April (water temperature, 15 C). The larvae trapped in cheesecloth averaged 11.8 (9 to 17) mm.

These data suggest an approximate period of embryonic development of 18 days at a temperature of 15 to 18 C, which is about twice as long as that for embryos raised at a temperature of 25 C.

Larvae

The term "larva" refers to the feeding individual having external gills from the time of hatching (free of gelatinous envelopes) until either the gills are resorbed (adults or subadults) or until gilled individuals attain sexual maturity (neotenes).

At hatching, larvae are 9 to 10 (body about 6 and tail 4) mm. Balancers are absent. The head is large with prominent black eyes. Dark pigmentation is lacking ventrally, is sparse ventrolaterally, and is extensive dorsally and dorsolaterally. Consistent pattern features are a middorsal row of unpaired dark blotches alternating with four to six pale blotches (occasionally with scattered melanophores), and a pale postocular spot that is often continuous with a pale dorsolateral stripe on the body (Fig. 4); this pattern is evident in larvae 17 mm long. This dorsal pattern seems to differ from that of paired dorsal dark blotches ascribed to hatchling larvae by Bishop (1941: 164, Fig. 33c) and Brandon (1961:382).

Larvae 22 to 23 mm and at all larger sizes, including neotenes, are generally dark green or olive-green; occasional larvae are pallid, mostly white. Two consistent features of pattern—a black preocular streak and a dark, somewhat diffuse tail tip—become indistinct or

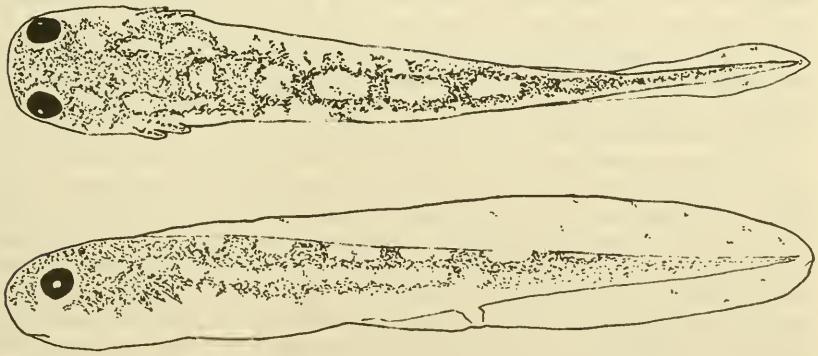

Fig. 4. Dorsal and lateral view of hatchling larva, 9 to 10 mm in total length, of *Ambystoma tigrinum* showing characteristic pattern of pale lateral stripe and middorsal blotches.

absent with increasing size, especially the black tail tip; the black preocular streak may be evident in large neotenes. Contrasting patterns are evident in larvae and presumably signify the advent of transformation (Fig. 9); the pattern seems to develop initially on the tail. Larvae 22 to 23 mm have small forelimbs. Hind limbs were first noticed when larvae were 28 mm; the hind limbs are about 2 mm long when larvae are 36 mm long. Larvae up to a size of at least 110 mm show a bronzish iridescence on parts of the body and often have a row of golden spots on the sides.

Growth of Larvae

The rate of growth was recorded for a few larvae that hatched in the laboratory; conditions were not suitable for continued growth and these larvae eventually died. The temperature varied from 22 to 24 C. Four hatchling larvae increased 2 (from 10 to 12) mm in about two days, whereas three larvae that hatched under the same conditions increased 3 (from 10 to 13) mm in five days. Three larvae, representing a different set of hatchlings, increased 2 (from 15 to 17) mm in about four days, 5 (17 to 22) mm in 12 days, and 6, 8, and 13 (22 to 28, 30, and 35) mm in 12 days.

Data on growth rates were obtained at different times in the years 1964 and 1966 by periodically measuring marked larvae of various sizes that were placed in pens in the pond at Taylor Well. Larvae were marked for individual recognition by clipping digits (no more than one digit per limb). The maximum number of larvae in each pen varied from five to seven. The circular pens of hardware cloth had diameters of 26 inches. Individual growth rates are shown in figure 5. As expected, growth rates of larvae of all sizes were slower in winter (February-March) than in summer (May-September).

In winter, from 15 February to 7 March 1964, 13 larvae ranging from 65 to 152 mm increased an average of only 3.3 mm; the water temperature ranged from 9 (February) to 14 (March) C. Some of these larvae showed no increase in length. Of these 13 larvae, six increased from extremes of 110 and 152 to 112 and 155 mm, showing an average increment of growth of 2.5 (0 to 5) mm; seven smaller larvae increased from extremes of 65 and 90 to 66 and 94 mm, showing a slightly higher average increment of 4.0 (0 to 8) mm.

In summer and early fall (17 May through 21 September), 13 larvae ranging from 48 to 100 mm increased an average of 15.1 (9 to 18) mm; water temperatures ranged from 20 to 30 C. From 17 May to 5 June 1966 (water temperatures 25 and 30 C, respectively), two larvae 98 and 100 mm increased to 115 and 118 mm, respectively, an average increase of 17.5 mm; in this same time period a small larva 48 mm long increased 13 mm to 61 mm (not depicted in Fig. 5). From 3 July (water temperature not recorded) to 10 August 1964 (water temperature, 26 C), five larvae increased from extremes of 86 and 95 to 97 and 110 mm, showing an average growth increment of 14.2 (9 to 18) mm. From 27 August to 21 September 1964 (water temperatures 20 and 23 C, respectively),

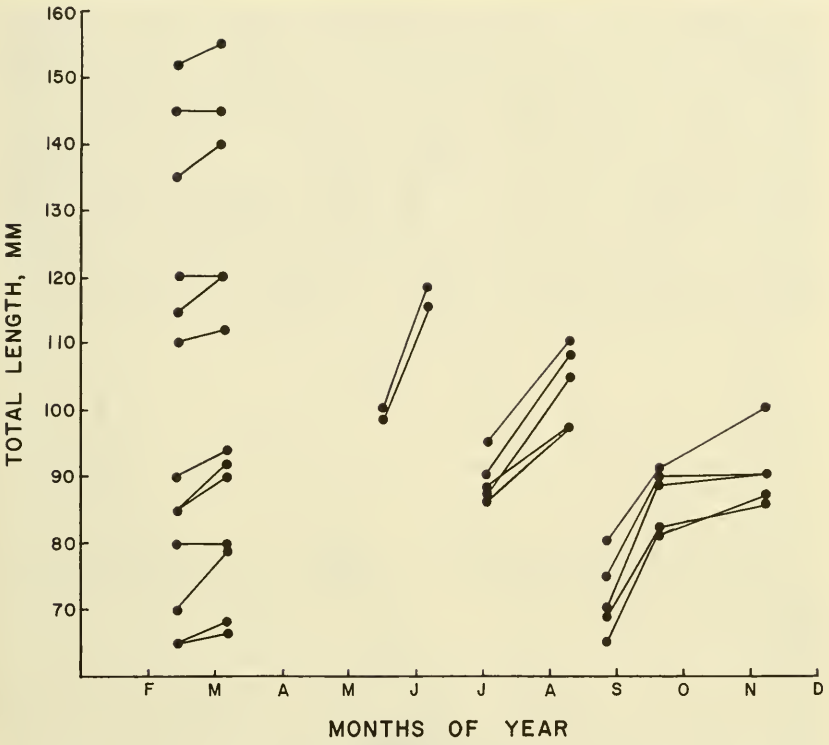

Fig. 5. Growth rates of individual salamanders of different sizes in different months of different years (see text).

five larvae increased from extremes of 65 and 80 to 82 and 92 mm, showing an average increase of 15.4 (12 to 18) mm.

Also depicted in figure 5 is a retardation in growth rate (from 21 September to 8 November 1964) of the five larvae that grew rapidly from 27 August to 21 September. These larvae increased to extremes of 86 and 100 mm by 8 November, showing an average increase of only 3.4 (0 to 8) mm. The water temperature on 8 November was 16 C. Four of the five larvae had gill stubs, indicating transformation; these larvae increased 0, 1, 3, and 5 mm, whereas the one gilled larva increased 8 mm. Although the low temperature may have been a factor, the slow rate of growth is attributed to the physiology of transformation.

Seine samples in 1966 provide data on the collective growth rate of larvae hatched in the spring of that year. The pond at Taylor Well was dry in the summer of 1965. Following heavy rains, seining operations revealed no salamanders either in the fall of 1965 or in the winter months of 1966. Perhaps bulldozing activities to enlarge the pond in the summer of 1965, and a torrential four-inch rain on 4 September that caused mild flooding, contributed to disrupt the

fall breeding pattern. On 19 March 1966 no larvae were found after a diligent seining operation, but embryos (eggs) were extremely abundant. Some of these embryos were in late stages of development and hatched sometime prior to 26 March, whereas other embryos in early stages of development hatched about 6 April (see section on embryonic development for further data). It is assumed that egg deposition did not occur in the fall of 1965 and that these hatchling larvae were the only larvae in the pond. Although the four seine samples on 17 May, 5 June, 4 July, and 16 August do not indicate all sizes or size extremes, the general trend of growth of larvae is probably adequately expressed by the histograms shown in figure 6.

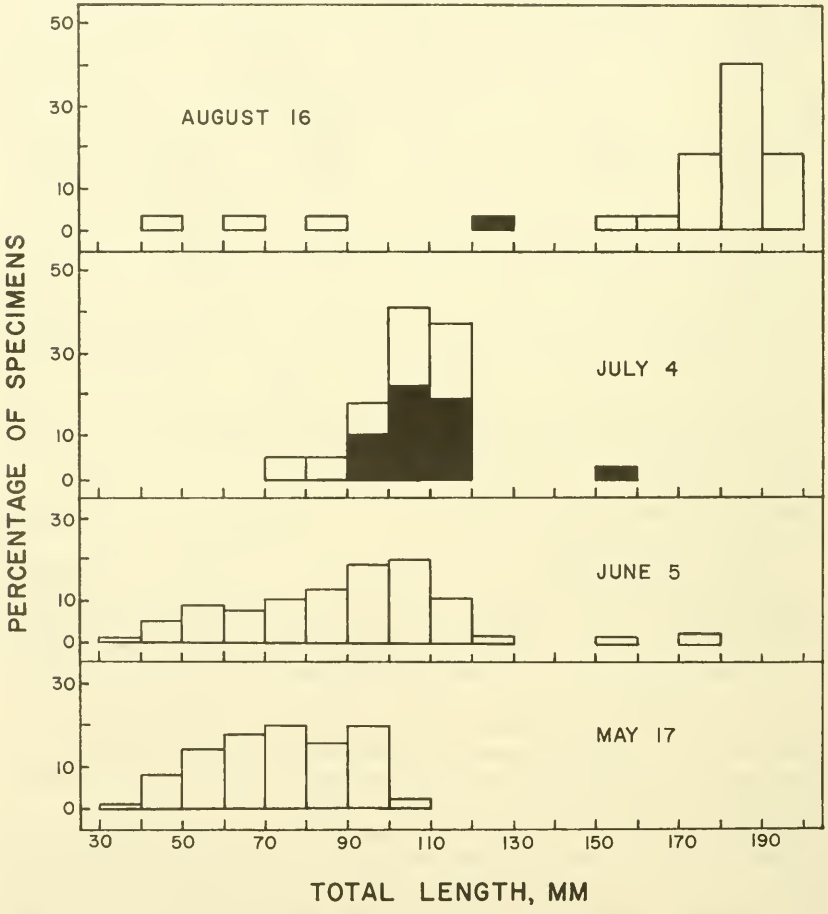

Fig. 6. General growth trend of larvae hatched in interval 23 March to 6 April 1966 in months of May, June, July, and August; solid parts of bars indicate subadults (see text).

On 17 May, larvae ranged from 39 to 101 mm; most larvae (74 percent) ranged from 61 to 100, averaging 81.6 mm. On 5 June, after a lapse of 18 days, larvae ranged from 38 to 176 mm (only three larvae, 155, 174, and 176, exceeding 122 mm); most larvae (74 percent) ranged from 71 to 117, averaging 97.0 mm. The average increment of increase for most larvae (74 percent of each sample) was 15.4 mm, which is about the same rate of growth recorded for individually marked larvae observed in pens in the same time interval. Presumably, some larvae are capable of growing to a length of 176 mm in about 74 days (23 March to 5 June).

About one month later, on 4 July, the sample of salamanders contained about equal numbers of larvae and transformed subadults. Previously, however, in the period 5 June through 11 June, many larvae were subjected to stress when they were trapped by the receding water level in an isolated, drying, shallow pool; some of these trapped salamanders (six of the largest, 103 to 118, averaged 106.8 mm) were transforming to subadults as evidenced by short gill stubs (none were preserved; see section on transformation for further data). Water in the adjacent large pond averaged some three feet in depth. Later, on 27-28 June, heavy rains (approximately 1.5 inches in two hours in El Paso) filled the pond so that subsequent seining operations were difficult and confined to the periphery of the pond. The sample obtained on 4 July included salamanders ranging in total length from 75 to 120 mm, except for one transformed individual of 155 mm. Most salamanders (87 percent) ranged from 95 to 120 mm; of these, however, over half (55 percent) were transformed subadults. These subadult salamanders averaged 107.0 (97 to 120) mm and seemed to represent those larvae that moved overland to the large pond after transformation under stress. Some larvae in the large pond, however, may have transformed in the absence of stress conditions. Most larvae (those included with the subadults, 87 percent) also averaged 107.0 (95 to 114) mm in total length. The average increment of increase for these larvae since 5 June was 10.0 mm. Since growth is retarded during transformation, the average size of the larvae would be expected to be larger than that of the subadults. This lack of larger larvae is perhaps due to the difficulty in obtaining an adequate sample because of the deep water. That the bulk of the larvae in the July sample should be larger than is indicated in figure 6 is suggested by the general maximum size-frequency trend in growth noted in the adjacent months.

On 16 August the pond was still near maximum depth, owing to another torrential downpour on 2 August (approximately two inches in one hour that caused minor flooding in El Paso). Larvae ranged from 43 to 198 mm. Most larvae (79 percent) ranged from 175 to 198, averaging 185.6 mm. The average increment of increase for these larvae since 4 July was 78.6 mm in 43 days or 1.8 mm each day; this rate of growth is excessive, since the bulk of larvae in the July sample should probably average larger in size. However, rapid growth might be expected, owing to the latent influence of the heavy rains on 2 August that enlarged the pond to provide less crowded

conditions and more nutriments. The small larvae presumably represent those of arrested development or late hatchlings since no eggs or spent gelatinous envelopes could be found after a diligent search.

On 22 September a few embryos in late stages of development were discovered, as well as one sexually mature male (180 mm long) with small gill stubs (recently transformed). A sample obtained on 30 September using a larger seine (12 foot) than that used previously (6 foot) yielded few salamanders after many hauls; the full pond was difficult to seine. One subadult measured 157 mm, and two sexually mature males measured 210 and 213 (smallest recently transformed with gill stubs about 3 mm long); four larvae ranged from 210 to 220, and two smaller larvae were 195 and 100 mm. The four large larvae averaged 215.8 mm, indicating an average increment of increase of 30.2 mm since 16 August.

The next seine sample taken the following year on 15 April 1967, when the water level had receded considerably, yielded larvae ranging from 47 to 233 mm, subadults from 160 to 180, transformed mature males from 195 to 236 mm, and four neotenic individuals—two males of 245 and 260 mm, and two females of 246 and 252 mm. The largest larvae doubtless represent those hatched from eggs deposited in the spring of 1966. The eight largest larvae (including the four neotenes) averaged 240.1 (225 to 260) mm, showing an average increase since 30 September of 24.3 mm. The sample obtained on 15 April 1967 was the first since operations began in September of 1962 that contained neotenic individuals. Also, 1966 was the first year since this study began that the pond was known to have had water at least three feet deep throughout the year.

The data suggest that growth rates are variable, with higher temperatures and probably lower population densities providing for the most rapid increments of increase. Growth rates seem to be slowed during transformation. Individual larvae attained a size of 260 mm after a period of about 388 days (23 March 1966 to 15 April 1967); this size-time correlation agrees with data provided by Glass (1951). Permanent water tends to promote neoteny.

Transformation

Individuals that transform prior to attaining sexual maturity are referred to as subadults, whereas sexually mature transformed individuals are referred to as adults. Larvae in the pond at Taylor Well have the capacity to transform at varying sizes exceeding about 90 mm. Most, if not all, of the smallest subadults probably transform under conditions of stress. The smallest subadult measured 88 mm at the time of complete transformation but, after a few years of preservation, now measures 82 mm (Fig. 9). Some larvae transform spontaneously (no apparent stress conditions), whereas others fail to transform and become sexually mature or neotenic. Obligate neotenes are unknown. Knopf (1962) noted metamorphic variation among individuals from the same lake in the Texas Panhandle.

Under natural conditions, drying of habitat in late spring and early summer causes transformation (Webb, 1969; Gehlbach, 1965). On 5 June 1966 a small pool, isolated some 15 feet from the large pond, contained about three inches of water (temperature 30 C in late afternoon). None of the larvae in this pool exceeded 120 mm. On 8 June evaporation had confined water to several shallow puddles interconnected by wet mud. Several desiccated, small larvae, 40 to 60 mm, were imbedded in the drying mud. The water in the shallow puddles was one to three inches in depth where the tail fin or back of the largest larvae was often exposed. Many of the largest larvae were in the process of transformation and had only gill stubs; six of them averaged 106.8, ranging from 103 to 118 mm. In bright sun from 3:00 to 4:45 p.m. (air temperature 35 C), two salamanders were observed to move from puddle to puddle over the wet mud. Three days later in the afternoon of 11 June, only two small depressions of wet mud with wriggling, air-gulping, mud-caked larvae remained. These gilled larvae showed no signs of transformation (the three largest measured 80, 85, and 90 mm) and undoubtedly died. The majority of these larvae, whose growth had been traced since hatching, transformed after a period of approximately 78 days (23 March to 9 June; Webb, 1969). After transformation, subadults return to water, if available; the food of subadults indicates an aquatic habit (see section on food). If water is not available, salamanders presumably take refuge in rodent burrows; Hamilton (1946) noted their occurrence in this retreat in summer in central New Mexico.

Larvae may transform without desiccation of habitat, which is the usual developmental pattern for *Ambystoma tigrinum* in the eastern United States (Brandon and Bremer, 1967). Recently transformed males bearing small gill stubs have been seined from deep cold water (22 and 30 September 1966).

Some small larvae, about 40 to 50 mm, that were seined from the pond at Taylor Well on 2 February 1963 were placed in an aerated aquarium containing tap water about one foot deep with a relatively constant temperature near 25 C. The larvae were fed bits of liver and showed variable growth through March. In April, complete transformation of eight larvae occurred at the following sizes (and dates): 7 April—100 mm; 10 April—105; 11 April—88; 12 April—105; 13 April—103; 14 April—91 and 105; and 19 April—97 mm. These larvae, 88 to 105, averaged 99.3 mm. One larva that grew much faster than the other larvae was transferred to another aquarium because of its cannibalistic tendencies; this large larva in tap water at the same temperature transformed on 23 April at a size of 131 mm. Two slow-growing larvae showed no signs of transformation on 4 May at sizes of 76 and 85 mm. Thirteen large larvae showing no signs of transformation were seined on 16 August 1966 (water temperature not recorded) and were transferred to tap water (about 25 C) in the laboratory; all larvae were completely transformed by 31 August and averaged 176.0 (165 to 185) mm. The water temperature, relatively higher than at Taylor Well, rather

than the chemistry of the tap water probably prompted transformation.

There is some further evidence that cold water prevents transformation. Three dark brown, patternless, similar-sized larvae obtained from a permanent coldwater (relatively constant near 10 C), dimly illuminated, rocky pothole in a small cave in the Hueco Mountains east of El Paso demonstrated varying degrees of transformation in the laboratory. None transformed in room-temperature tap water. Two transformed when thyroxine tablets were added to the water (concentration unknown); the third larva, a neotenic female 185 mm long, failed to transform after corresponding thyroxine treatment and showed only shriveled gills after prolonged living in warm, room-temperature tap water. Three neotenes were received from Mr. Bob Frampton (Alamagordo, New Mexico) who raises "waterdogs" for commercial purposes. These neotenes measured 305 (female) and 298 and 310 (males) mm and were raised and received from Frampton in clear, cold water (temperature unknown); when transferred to warmer tap water (about 25 C) the three neotenes transformed.

Individual larvae seem to respond differently to the same stress conditions. In a sense, the term "environmental stress" is relative; the usual wet-dry annual cycle, in which larvae transform at varying sizes, can be considered as providing more "stress" than the continuous wet cycle in which water is continuous throughout the year and there is selection for neotenes.

The exact factors responsible for transformation are unknown. Gehlbach's observations (1965) that increased temperatures and decreased oxygen supply associated with drying of habitat promote transformation agree with our observations. Our data also support the comments of Smith (1969) and Wintrebert (1907) that the limits of individual variation in the capacity to transform are genetically determined but modified by environmental conditions.

Size at Sexual Maturity

Sexual maturity of all salamanders was determined by dissection. Rodgers and Risley (1938) and Baker and Taylor (1964) have described the morphology of the urogenital system of *Ambystoma tigrinum*. Our criteria for sexual maturity are a swollen and convoluted Wolffian duct in males and oviduct in females; these ducts are straight and narrow in immature salamanders. Rodgers and Risley (1938) have shown that the development of Wolffian ducts is correlated with the appearance of spermatocytes, and of oviducts, with the growth of ovocytes. In sexually mature males, cloacal lips are black and swollen. Some females having oviducts only slightly swollen and convoluted, suggesting the onset of sexual maturity, are referred to as submature in figure 7.

Transformed individuals of both sexes are sexually mature at a smaller size than neotenes, and there seem to be no sexual differences in size at sexual maturity (Fig. 7). Data, however, are scanty for

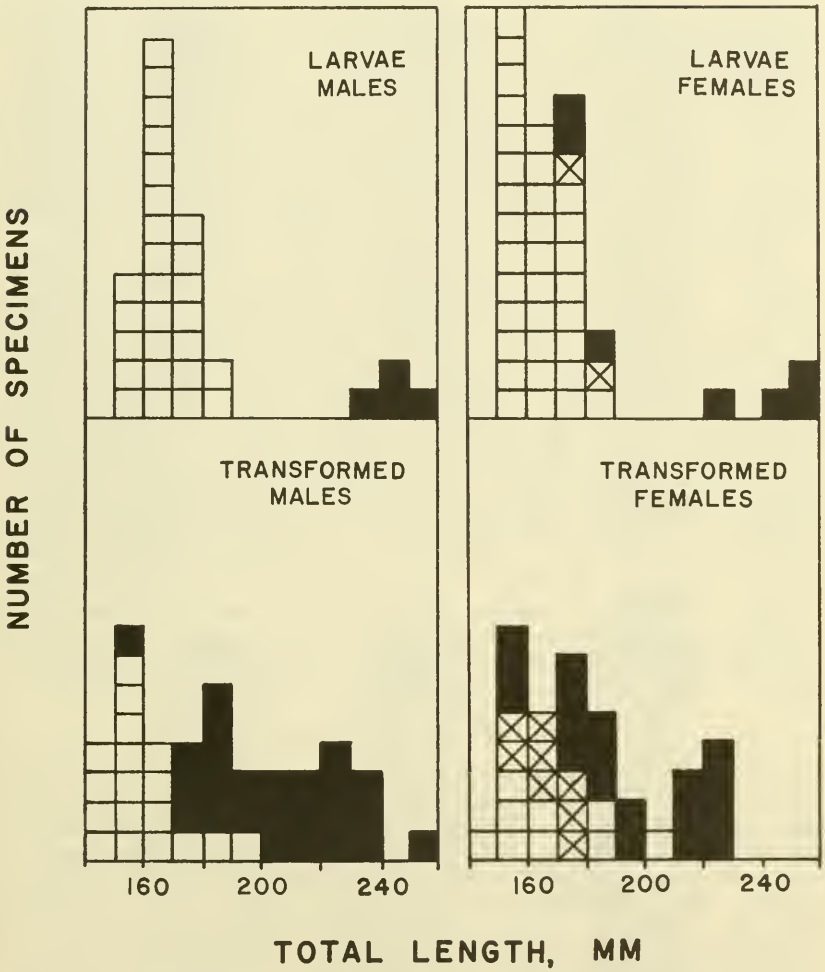

Fig. 7. Size at sexual maturity in males and females of larvae (neotenes) and transformed individuals; open squares, immature; diagonal-marked squares, submature; solid squares, sexually mature. Each square represents one individual.

neotenes, especially males. Our sample of 25 transformed adult males averages 204.4 (156 to 256) mm, and of 19 transformed adult females averages 190.5 (154 to 222) mm. Corresponding data for neotenic males are lacking (four measure 236, 240, 245, and 260 mm), but the advent of sexual maturity seems to occur at a larger size than in transformed males. Seven neotenic females average 215.9 (172 to 255) mm.

If larvae smaller than 150 mm transform, they will be subadults. If larvae exceeding 150 mm transform, they will be adults either at transformation or shortly thereafter. Two sexually mature

salamanders seined at Taylor Well measured 180 and 210 mm and had recently transformed, as evidenced by short gill stubs. Transformation under stress may delay the onset of sexual maturity. Thirteen larvae induced to transform in tap water in the laboratory showed no signs of sexual maturity after complete transformation on 31 August when they averaged 176.0 (165 to 185) mm; about one month later on 1 October and after a slight increase in length, the males, ranging from 175 to 190 mm, showed partially swollen and black-edged cloacal lips and the onset of sexual maturity.

Assuming 150 mm as the smallest size at sexual maturity in both sexes of transformed salamanders and 170 mm in both sexes of neotenes, the data on growth of larvae suggest that sexual maturity may be attained after a period of development of only 74 days or about 2½ months (23 March to 5 June 1966; hatching known to have occurred in interval 20-26 March). Most larvae are capable of becoming sexually mature after a period of 146 days or about five months (23 March to 16 August 1966), when an average size of 185.6 mm is attained; the size minimum for sexual maturity in most of these salamanders is probably attained in about four months. The period of larval development is doubtless variable depending on the time of hatching and the permanency and amount of water. We have no data on growth rates of neotenes and transformed individuals. If both morphotypes hatch at about the same time, larger neotenes are probably of about the same age as smaller transformed individuals, since growth seems to be retarded during transformation.

Subadults and Adults

The color and pattern of transformed salamanders is variable and depends largely on the size at transformation. Most of the smallest subadults (near 100 mm) are a uniform dark olive green or brown with only an obscure and diffuse mottled and blotched pattern; but some of them (as small as 94 mm) may show contrasting patterns (Fig. 8). The contrasting pattern, then, is not correlated with the advent of sexual maturity. The mostly patternless subadults undergo ontogenetic change and acquire a contrasting pattern with increasing size; the degree of ontogenetic variation in transformed salamanders (Gehlbach, 1965) has not been studied. Contrasting patterns are evident in larvae presumably just prior to transformation (Fig. 9). Two extreme pattern-types of adults are (1) ground color mostly black with pale yellow markings and (2) the reverse of that pattern, with the ground color mostly pale yellow with few black markings. Pattern type 1 is most common, but patterns intermediate between the two types occur. Often the ground color is olive or brownish so that patterns are noncontrasting.

Food

Data on kinds of food consumed is scanty. Food capture is probably triggered primarily by movement. The carnivorous diet of tiger

Fig. 8. Variation in pattern of subadult *Ambystoma tigrinum* that transformed under stress. Top, mostly patternless; left to right, 82, 91, and 95 mm total length. Bottom, distinctly patterned; left to right, 94, 107, and 100 mm total length; photograph by Rayburn Ray.

Fig. 9. Variation in pattern of *Ambystoma tigrinum* larvae just prior to transformation; top to bottom, 160, 168, and 160 mm total length.

salamanders and the cannibalism of larvae is well known. Cannibalism was frequently observed among captive larvae less than 100 mm long. The larvae constantly nip at each other. Individuals may be ingested either head or tail first. The size discrepancy between predator and prey must be about 15 to 20 mm, otherwise the prey larva, usually only partly ingested and killed, is regurgitated. Beetle elytra and mud balls held together by strands of *Spirogyra* were either defecated or observed in stomachs of large larvae and recently transformed individuals in the size-range 150 to 170 mm. Captive adults and subadults ate insects, including grasshoppers, cockroaches, crickets, houseflies, june bugs, and moths, and at times were observed to ingest parts of their shed epidermis.

Food items in stomachs of 13 subadults, 90 to 120 mm long (collected 3 February 1968) included insects (identified by James R. Zimmerman, New Mexico State University) and tadpoles of *Scaphiopus*, indicating an aquatic habit and ingestion of nonaquatic insects that fall to the surface of the water. Little and Keller (1937) also recorded these same food items for salamanders from the Jornada range headquarters about six miles north of Taylor Well. Tadpoles of *Scaphiopus* were most frequent. The frequency of occurrence (number of individuals/number of stomachs) for each food item is as follows: Spadefoot toad (*Scaphiopus*) tadpoles, bodies 7-8 mm long, 130/13; Orthoptera, 1/1; Isoptera (winged), 34/10; Corixidae, 1/1; Coleoptera, unidentified fragment, 1/1; Hydrophilidae (*Berosus*), 1/1; Formicidae, 11/6.

Mortality

Although evidence is lacking, cannibalism probably occurs among larvae at Taylor Well, and some larvae probably fall prey to the predaceous larvae or adults of aquatic insects. Many small-sized larvae desiccate when the pond dries in summer. Transformed individuals that seek refuge in the mud cracks after all water has evaporated can live probably for only a short time; Webb (1969) found one desiccated individual during limited excavation.

There is evidence that larvae or subadults exposed in drying pools of shallow water or shortly after being exposed are preyed upon by coyotes. A person (name unknown) knowledgeable concerning the upkeep of Taylor Well visited briefly with Webb on 17 April 1964 when he was digging and searching for salamanders in the mud cracks. This person said that when the pond was mostly dry with scattered soft mud depressions on 7 April, many larvae were thrashing in the mud or had desiccated; he also pointed out impressions of coyote tracks and scratchings in the mud and said that coyotes, as well as bobcats, eat the salamanders. That coyotes frequent Taylor Well is evidenced by the discovery of two dead coyotes (seemingly poisoned) found along the south shoreline on 1 March 1969.

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NOTES ON THE LIFE HISTORY OF *AMBYSTOMA TIGRINUM NEBULOSUM* HALLOWELL IN UTAH

Wilmer W. Tanner[1], D. Lowell Fisher[2] and Thomas J. Willis[1]

The early life history of *Ambystoma tigrinum*, as it occurs in Utah and adjoining areas, has long been in need of study. A few studies have been conducted. Dr. V. M. Tanner (1931) provided us with the most important natural history information to date for this salamander. However, he was concerned primarily with its distribution in Utah and its food habits. Skousen (1952) studied the egg and early larval development of only a few eggs but did provide some pertinent information concerning the size of eggs and hatchling larvae. Hamilton (1948) reported the egg-laying habits of this subspecies from Muskee Lake, Colorado. Webb and Roueche (1971) have provided a rather complete life history study for a population of *Ambystoma t. mavortium* at Taylor Well, approximately 19 miles northeast of Las Cruces, New Mexico.

This study is confined to observations of the eggs, developing larvae, their growth rate, and the dates of their appearance as active larvae. A study of the food habits by means of stomach analysis from larvae and adults and an examination of early embryology will be reported at a later date.

Salamander Lake in Stewart Canyon on the northeast slope of Mt. Timpanogos (Utah) was selected as the study area (Figs. 1 and 2). The ease of access and the fact that it is fed and drained by the ground table water rather than flowing streams made this lake an ideal habitat for a study of larval salamanders.

Data have been gathered by four individuals. Unfortunately, each has been unable to complete the study for lack of time or other reasons. However, all the data available were obtained from Salamander Lake and involve the same breeding population. The data gathered by Skousen were taken in 1950; by Fisher in 1967; and by Willis in 1970-71.

Fisher did not find eggs and his data are primarily concerned with developing larvae and ecological conditions effecting growth.

Willis found the eggs and observed a female as she laid eggs in a large aquarium. Hatching was observed, and the early stages of larval development were studied. With the data from Willis, the life cycle can be generally outlined.

Eggs and Egg Deposition

The first eggs were secured by Skousen on 26 May. Only two

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Fig. 1. Salamander Lake 8 June 1967, showing the lake at near capacity.

Fig. 2. Salamander Lake 20 August 1967, same view as figure 1 showing the abundant growth of plants in the reduced water.

eggs were measured, and these had the following dimensions (unpublished M.S. thesis):

Outer Casting	Envelope I	Envelope II	Envelope III	Vitellus
9.1	5.1	4.6	3.9	2.2
8.5	5.4	4.6	3.8	2.1

Willis first visited the lake on 3 May 1971. There was snow in rather large patches near the lake, and it appeared as though the ice had only recently melted. A number of large larvae were present in the lake. Five larvae ranged in size from 77 to 111 mm, total length, and 42 to 60 mm in S-V length. Four adults were seen on 13 May, and, of these, 3 were males and 1 a female. On 15 May, the weather was misty and a light rain continued during the day and into the evening. Apparently the rain stimulated emergence; at least by the next day, 25 adults were counted in the lake.

Eggs have been seen and/or collected by us and other students at Salamander Lake and other nearby locations, however, the observations made by Willis concerning the eggs and oviposition are the most complete. A gravid female (98 mm S-V) taken on 15 May and placed in an aquarium laid a clutch of eggs on 16 May. The size of the vitellus in 11 of these laid on a small twig had a range in diameter of 1.7-2.5 and averaged 2.12 mm. The average compares well to that of Skousen and to that reported by Webb and Roueche (1971). We found it difficult to measure accurately the dimension of the surrounding envelopes owing to the position of the attached eggs. We did confirm, however, that there was considerably more variation in the diameter of the various envelopes than we noted in the vitellus.

The eggs were laid singly or deposited in pairs or in strings ranging in numbers from 3-4 to as many as 15 in one linear string. Eggs are laid on either floating or submerged twigs, rocks, or on the stems of growing vegetation. In all instances, the eggs were attached to an object. We saw none that were floating free or were loose on the bottom of the lake or the aquarium. We note that there were no egg clusters. Each egg, as it is laid, is attached by the outer gelatinous layer to the object on which it is laid. The observations of Willis indicate that each egg is laid separately, that is the female possesses the ability to produce one egg at a time and to place it on the object selected for its deposition. The fact that more than one egg was laid, and that they may occur in rows, seems to be coincidental to the fact that egg laying, and where each egg is deposited, is controlled by the female. This allows her to distribute the clutch in many areas throughout the lake.

The eggs hatched on 22 May, beginning at approximately 3:00 PM and continued until 8:00 PM, 155 hours from the time they were laid. The water in the aquarium was maintained at approximately 19 C (room temperature). Skousen reports 2-3 weeks from the time eggs were laid in the lake until hatching, and Webb reports

204 hours (8.5 days) in the laboratory at 25 C for the New Mexico population.

A series of 24 hatchlings (May 1971) were preserved and measured soon after they had been freed from the gelatinous egg mass. They ranged in size from 9.1 to 13.6 mm and averaged 11.9 mm. At this early stage, the larvae are distinctly tadpolelike, having a large head, three pair of external gills, well-developed black eyes, but without legs and with little pigmentation. The front legs appear in larvae 17 to 20 mm in total length. Hind legs were not seen in larvae less than 25 mm long.

Larval Growth

During the summer of 1967 (June through August), Lowell Fisher studied the larvae at the lake. Larvae were obtained from the lake by means of a large aquatic insect net with a one-foot-square opening and all specimens were preserved immediately in 10 percent formaldehyde.

The total length of all larvae were taken in millimeters and placed on a graph for comparison. Temperatures of water and air were recorded. The precipitation data were supplied by Mr. E. Arlo Richardson—the weather bureau climatologist of the Department of Soils and Meteorology at Utah State University, Logan (Fig. 3).

The first larvae of the summer were taken on 2 July. Weekly collections were then made until the end of August. The sudden appearance of small new larvae on 30 July presented an interesting but perplexing problem. Comparisons between the newly hatched larvae and rainfall data indicated a distinct correlation between precipitation and breeding times (Fig. 4). The egg-laying to hatching time of two weeks as reported by Skousen (1952), and the rainfall data from Richardson, seemingly provide the solution (Fig. 5). It was also noted that the only appearance of adults during the sum-

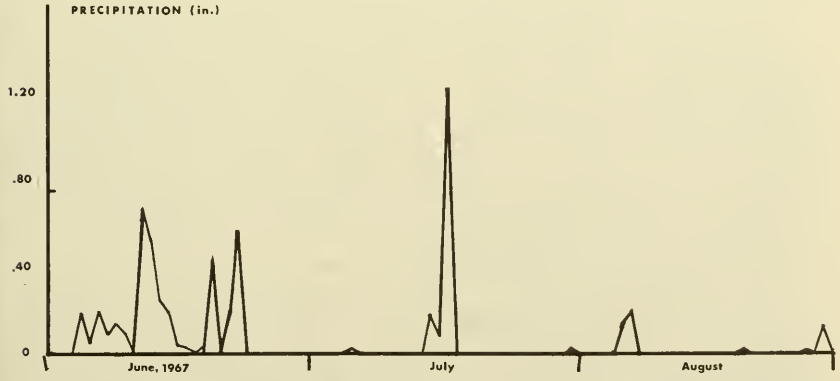

Fig. 3. Precipitation from 1 June 1967 to 31 August 1967, taken from the records of the National Forest Weather Station a short distance from the lake.

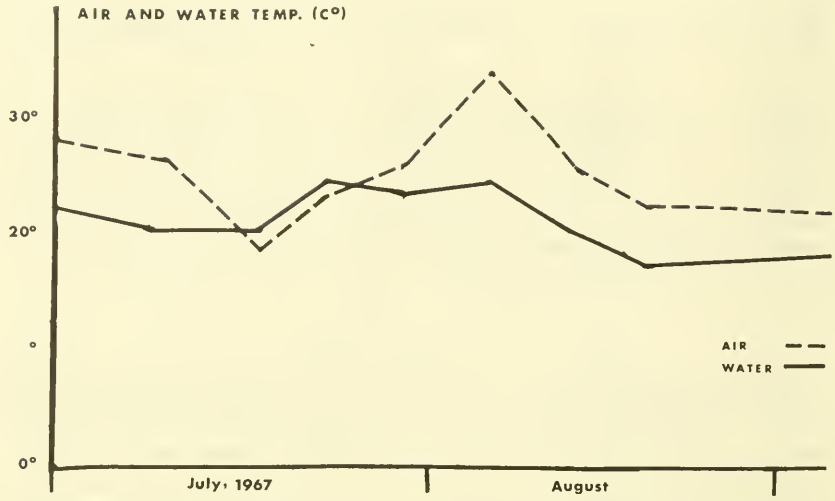

Fig. 4. Air and water temperatures recorded for July and August 1967. These represent daily recordings taken by Fisher at the lake.

mer seemed to occur immediately following a heavy rainstorm. Days in which rainfall exceeded one-fourth inch invariably resulted in adult salamanders being found in the swimming pool of the Brigham Young University Family Camp located two miles south of Salamander Lake. Adults were found in the pool at no other time.

We also noted that those larvae appearing on 30 July had an accelerated growth rate as compared to those hatched in June (Fig. 6). This we assume resulted because the water temperature was approximately 4 C warmer than in preceding weeks and remained warm for approximately two weeks after their appearance (Fig. 4). There was also a greater increase in vegetation and aquatic arthropods. Such factors are, we believe, the primary factors responsible for the rapid rate of development.

Apparently, heavy rain during the spring, summer, or fall months serves as a breeding stimulus to *Ambystoma tigrinum*. It is not unusual in Utah to find larvae of different ages in the mountain ponds and lakes. An entry in a field book (Tanner, 1938) indicates this size differential in several lakes on the SE rim of the Aquarius Plateau in late June. Such reproductive habits are seemingly appropriate for desert habitats where rains come irregularly. We note that tiger salamanders in Utah usually breed (lay eggs) at least once each year, usually in the spring.

In those individuals undergoing metamorphosis, it was observed that the general body appearance was changed and they appeared smaller—although total length was not substantially reduced. Upon removal of the stomach, it was noted, without exception, that the stomach was completely empty and appeared in a generally contracted condition. The stomachs of nonmetamorphosing individuals

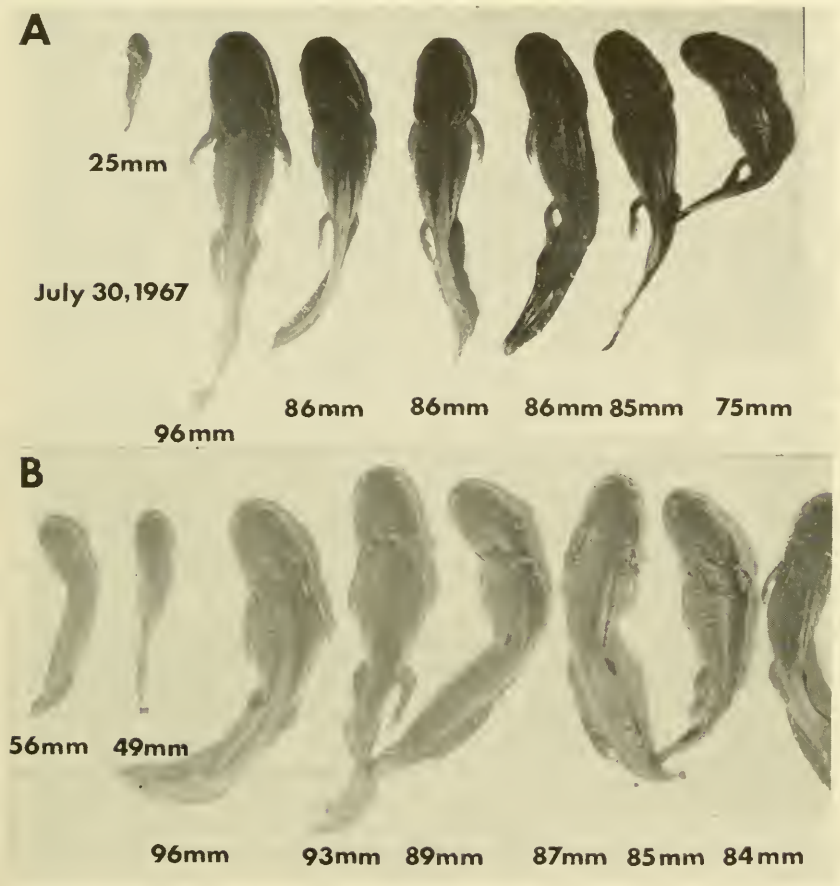

Fig. 5. Representative sizes of larvae as they appeared on (a), 30 July 1967, and (b), a second series as they appeared on 6 August 1967.

of the same collection contained food. It is evident that the larval forms do not feed, or do so sparingly, during the more active stages of metamorphosis. This is perhaps the result of the reabsorptions of the large dorsal and ventral fins of the tail and perhaps other organs.

We estimate, on the basis of our collecting data for 1967 (Fig. 6), that approximately 50 percent of the individuals were metamorphosed by the end of August. After a final exhaustive collection on October 11, only 3 larvae could be found in the entire lake. Under a log by the side of the lake, 1 small metamorphosed individual was also found. Most of the larvae seem, therefore, to complete metamorphosis by the end of one summer and to overwinter as young adults. Because weather conditions vary from year to year, we might expect considerable variation in the percentage of larvae that actually meta-

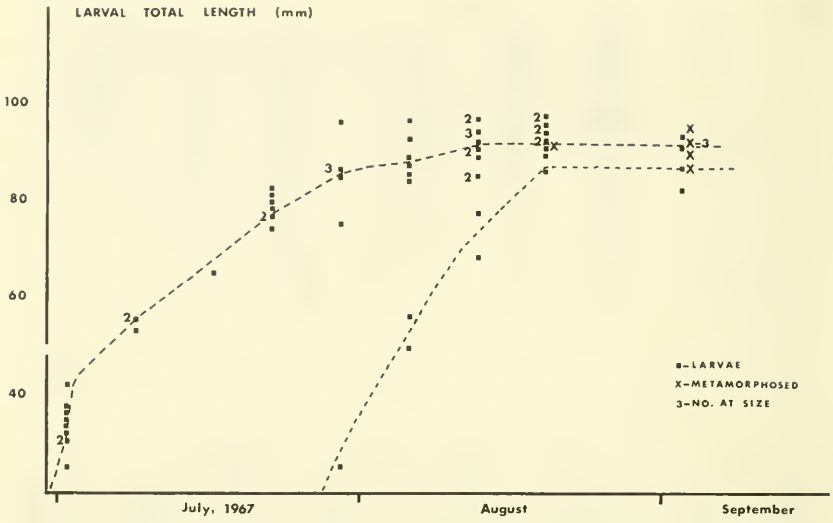

Fig. 6. Growth rates of the two age groups as they appear from July through August and into September.

morphose each year. In the spring of 1971, 5 large larvae were in the lake when it was first visited on 3 May. In 1970, large larvae were seen in the lake on 15 September, and, on 26 September, 10 larvae and 5 newly metamorphosed adults were found. The adults were only recently out of the small pond of murky water. They still had "gill buds" to indicate a recent transformation. The larvae were small and showed no signs of metamorphosis. There was only a small puddle of water remaining, an environmental hazard, which undoubtedly put stress on mature larvae to transform and results in the destruction of later generations whose morphological development is not complete. Only occasionally does this lake dry up, and it is obvious that late breeding occurring in August may result in young larvae unable to complete their growth before cold weather retards their development. Such larvae are carried over to the next spring if sufficient water is available; however, they do not occur in large numbers as compared with July of most years. Our observations indicate that heavy rains during the summer do trigger a breeding response on the part of a few adults after the main spring breeding season has passed. Such occasions provides two or more generations of larvae per year, some of which may not reach maturity until the next spring or summer.

Growth rate as indicated in figure 6 is dependent on several factors. Included among these are such items as: (1) An early or late spring permitting spawning at an early date. We note that snow and ice do not leave the lake at the same time each spring. In some cases there may be a time differential of three to four weeks. (2) Temperature variations resulting from cool, wet springs

hold the temperatures down until later in the summer. Growth of larvae, as indicated, seems to be greatest during that part of the summer when water temperatures are greatest (25 C). In 1967 such a temperature occurred from mid-July to mid-August. However, this may also be modified if heavy rains persist during the months of July and August. (3) Salamander Lake is in a small basin and the accumulating water comes primarily from melting snow which had accumulated in drifts during the winter. If, therefore, large drifts are present, the cold runoff water retards the warming of the lake. (4) Weather conditions which would provide for an early development of aquatic growth would increase the food items available. We suspect that the abundance of food as well as favorable temperatures were responsible for the rapid growth of larvae hatched in July 1967.

We have not observed the extensive cannibalism in this population reported by Burger (1950) for a population in the Gothic area of Gunnison County, Colorado. We have not made extensive studies of food eaten, but have seen only a few instances of predation. Burger also projects a hypothesis that larvae require more than one growing season before metamorphosis occurs. It may be that the Gothic population at 8,000-10,000 ft would not have adequate time to mature, whereas the Salamander Lake population in Utah at about 7,000 ft does mature. We suspect, however, that what we have observed also occurs in Colorado—namely, that summer rains trigger late spring or summer breeding, which provides larvae of two sizes in the same pond. We also believe that overcrowding may result in cannibalism. We have not experienced a large larval population in any of the Utah ponds or lakes which has resulted in obvious cannibalism. In fact, during our extensive efforts in 1967, larvae were at times difficult to find in the heavy plant growth.

We have not found neotenic larvae thus far in any population of *A. tigrinum* in Utah. Axolotls do occur in *tigrinum* populations and one of us (Tanner) has either seen or collected such individuals from western Kansas and a pond near Shumway, Arizona. During the past 30 years, many populations have been observed throughout Utah without observing neoteny. We do not suspect that such a phenomenon cannot occur in the populations of the subspecies *nebulosum* but, rather, surmise that neoteny occurs where climatic and biotic factors do not place a heavy stress on the developing larvae. In desert or cold mountain habitats, periodic droughts limit the available aquatic habitats or destroy them. Cold weather, in which ice and snow reduce activity, limits or certainly circumscribes the activity of larvae. Such weather conditions reduce food production and may tend to reduce the cover normally found in a flourishing pond. Such stresses seemingly demand that larvae grow rapidly and metamorphose in order to escape from the rigorous and changing aquatic habitat. In contrast, a more uniform habitat such as those occurring in less variable climates are not placed under such stresses and can survive with equal success in the larval stage. We believe that such reasoning is plausible and may help to explain

rapid larval growth and early metamorphosis in deserts and cold mountain habitats.

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MOLLUSCA OF FISH SPRINGS, JUAB COUNTY, UTAH: REDISCOVERY OF *STAGNICOLA PILSBRYI* (HEMPHILL, 1890)

Richard H. Russell[1]

Abstract.—Twelve species of Mollusca are reported from the Fish Springs area in west central Utah, including *Stagnicola pilsbryi* (Hemphill, 1890). Most of the species are well known from Utah or the southwestern United States except *S. pilsbryi*, which is apparently endemic to Fish Springs.

The Fish Springs area, at an elevation of approximately 4,300 feet, is located on the southern edge of the Great Salt Lake Desert in western Juab County, Utah (Fig. 1). There is a series of 16 springs which arise from a fault zone along the eastern edge of the Fish Springs Mountains. The water from these springs is channeled into nine artificial impoundments having a surface area of over 4,000 acres (Fig. 2). The impoundments were constructed by the U.S. Fish and Wildlife Service, beginning in 1961, when the area was developed into a wildlife refuge.

In June of 1970, the Fish Springs area was visited to survey the molluscan fauna, specifically to ascertain the presence or absence of *Stagnicola pilsbryi*. This snail was collected in 1868 by Henry Hemphill and described 22 years later. The type locality was listed as "Fish Springs, Nevada"; but, as pointed out by Pilsbry and others, Hemphill tended to be cryptic (and at times erroneous) in his locality descriptions.

In the account of his journey, Hemphill wrote, "I collected a few specimens of this interesting shell in the month of June, 1868, at this locality after a long and hard day's ride of 40 miles horseback. Another long ride the next day of 50 miles to water compelled an early start and thus the opportunity to secure more specimens was lost." It might be assumed from his description that he was following the old Pony Express trail (a service discontinued in October of 1861). There was no water on the route from Simson Springs Station to Fish Springs Station, a distance of 39 miles. From Fish Springs Station west to Deep Creek Station (now the town of Ibapah) it was approximately 50 miles. During the time of the Pony Express, however, there was water at Willow Springs Station (now the town of Callao). Deep Creek is approximately 6 miles from the Nevada border.

Mollusca of Utah and the Great Basin have been monographed several times since Henderson's works of 1924 and 1936. Chamberlain and Jones (1929) catalogued the Mollusca of Utah, and others (such as Berry, 1922, Chamberlain and Roscoe, 1948, and Bailey and Bailey, 1951) have published on the Mollusca of this region.

Eight localities in the Fish Springs area were examined. These

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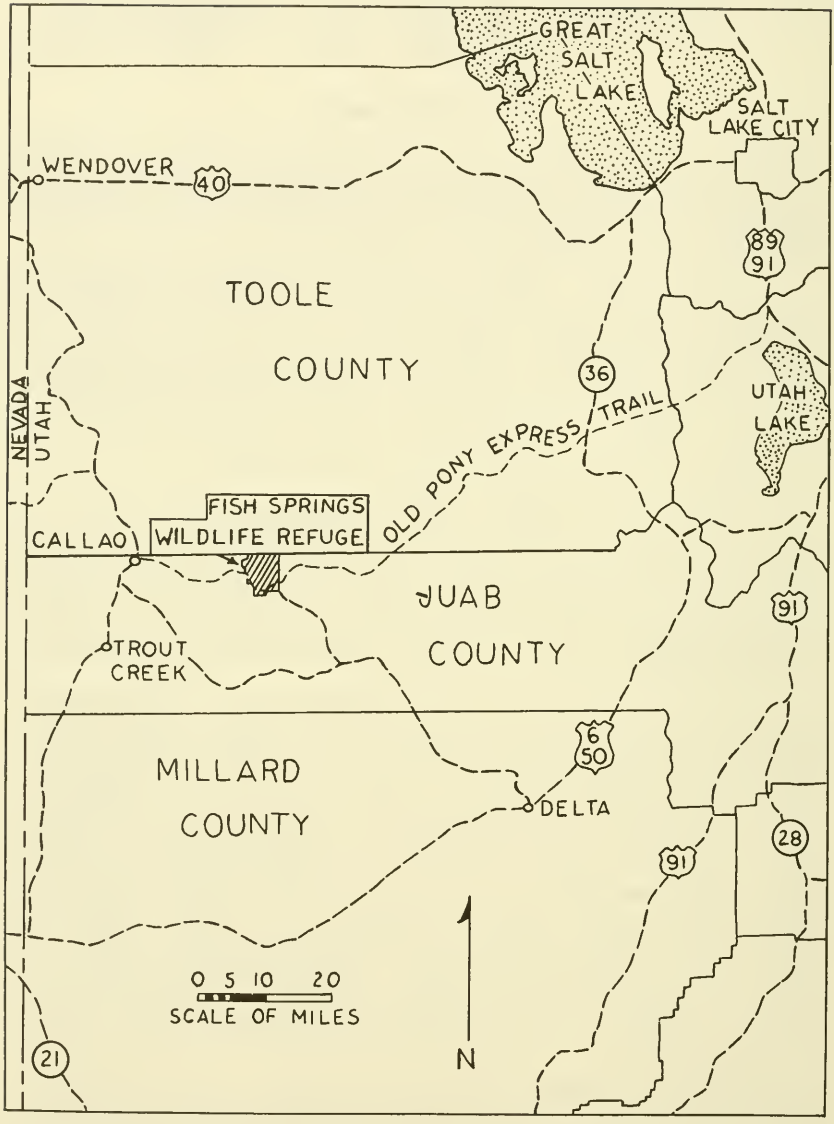

Fig. 1. Map of west central Utah showing location of Fish Springs.

are listed by numbers 2-8 in the appendix and are indicated by corresponding numbers on the map (Fig. 2). Cold Springs (locality 1) is outside the area covered by the map. Specimens sent to me in 1971 by Mr. J. Brent Giezentanner of the refuge staff are also included (locality 9 of map).

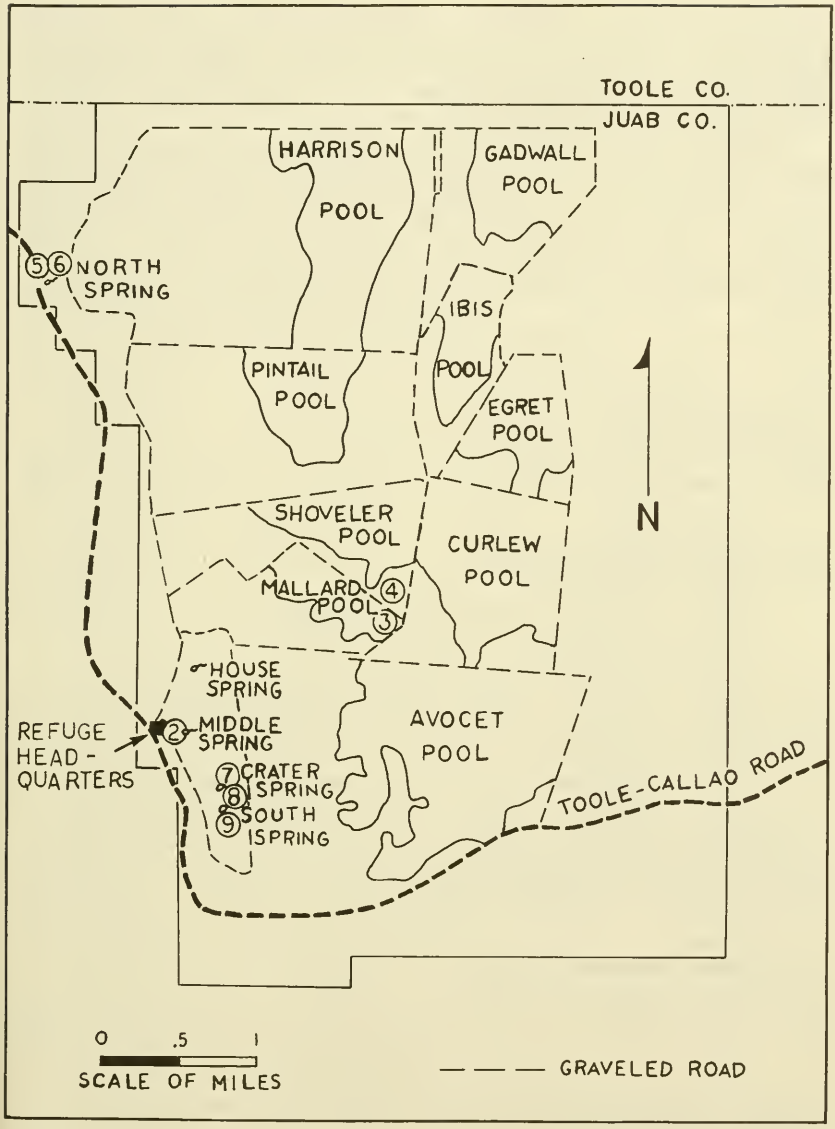

Fig. 2. Map of Fish Springs area. Encircled numbers refer to localities listed in appendix.

Systematic Discussion of Species

The molluscan fauna of the Fish Springs area (with the exception of *Stagnicola pilsbryi* and *Viviparus*) is typical of the Great Basin. In the following discussion, no attempt has been made to

include complete synonymies, as these are available in the literature. In general, a reference is given to the original description and to a figure (if the species was unfigured in the original description). Distributions are based upon records in the literature and collections at the University of Arizona.

The taxonomy of several of these families is in an unsatisfactory state. Consequently, the naming of *Oxyloma retusa*, *Physa virgata*, *P. utahensis*, and others is only tentative; the specific names which are used represent the best choices. All specimens have been deposited in the Invertebrate Museum, Department of Biological Sciences, University of Arizona, and in the collection of the author.

TABLE 1. Systematic list of Mollusca from Fish Springs

LAND MOLLUSCA (Gastropoda)
family Succineidae
1. *Oxyloma* cf. *retusa* (Lea, 1834)

AQUATIC MOLLUSCA (Gastropoda)
family Physidae
2. *Physa virgata* Gould, 1855
3. *Physa utahensis* Clench, 1925
family Planorbidae
4. *Helisoma* (*Pierosoma*) *subcrenatum* (Carpenter, 1857)
5. *Gyraulus* (*Torquis*) *parvus* (Say, 1817)
family Lymnaeidae
6. *Stagnicola* (*Hinkleyia*) *pilsbryi* (Hemphill, 1890)
family Ancylidae
7. *Laevapex* (*Ferrissia*) *californica* (Rowell, 1863)
family Viviparidae
8. *Viviparus* (*Cipangopaludina*) *chinensis malleatus* (Reeve, 1863)
family Valvatidae
9. *Valvata utahensis* Call, 1884
family Hydrobiidae
10. *Tryonia protea* (Gould, 1855)
11. *Fontelicella longinqua* (Gould, 1855)

Pelecypoda
family Sphaeriidae
12. *Pisidium insigne* Gabb, 1868

Oxyloma cf. *retusa* (Lea)

Succinea retusa I. Lea, 1834, Trans. Amer. Phil. Soc. 5:117, pl. 19, fig. 86. (T. L. Ohio, near Cincinnati).

Oxyloma retusa: Pilsbry, 1948, Acad. Nat. Sci. Phila., Monogr. 3, 2(2):785-788, fig. 421.

Distribution: Ohio west to Montana and south to Kansas (Pilsbry, 1948). Other described species may very well represent this species, and the range of *Oxyloma retusa* would then cover a greater area. The numerous Utah records of *Oxyloma haydeni* (cf. Chamberlain and Jones, 1929:116) might be based upon this species.

Occurrence at Fish Springs: Only shells were found (locality 7), as time prohibited a critical examination of terrestrial localities. During a wetter season of the year, *Oxyloma* could likely be found in much of the marshy area surrounding the pools at Fish Springs. Of this species Leonard (1943:240) has stated that it "thrives on the moist marshes and borders of the pools in the artesian basins, where it is frequently found on watercress."

Physa virgata Gould

Physa virgata A. Gould, 1855, Proc. Boston Soc. Nat. Hist. 1855-1856:128, 129. (T. L. Gila River and near San Diego).

Physella virgata: Chamberlain and Jones, 1929, Bull. Univ. Utah, 19(4):164, 165, fig. 76.

Physa virgata: Henderson, 1936, Univ. Colo. Studies 23(2):130.

Distribution: At present considered to be a southwestern species ranging from west Texas through Arizona and southern Utah to the west coast. Whether or not *Physa virgata* is a valid species or represents an eastern species remains to be seen.

Occurrence at Fish Springs: *Physa virgata* is generally found in pools and canals. This is the most widespread species at Fish Springs.

Physa utahensis Clench

Physa lordi utahensis Clench, 1925, Occ. Papers Mus. Zool., Univ. Michigan 161:8-10, pl. 1, fig. 5. (T. L. Utah Lake, Utah).

Physa utahensis: Chamberlain and Jones, 1929, Bull. Univ. Utah 19(4):162-164, fig. 75.

Physa utahensis: Henderson, 1936, Univ. Colorado Studies 23(2):130.

Distribution: Utah Lake, Utah (Clench, 1925), and from a spring seven miles south of Junction [Piute County], Utah (Henderson, 1936). Chamberlain and Jones (1929) discuss this species in some detail. Their inclusion of a lot from New Mexico is likely based upon *Physa humerosa* (Gould).

Occurrence at Fish Springs: This species was not seen alive in any of the marshes or canals but is known only from springs. Specimens were collected from Middle Spring, North Spring, and South Spring and were observed (but not collected) in House Spring.

Helisoma (*Pierosoma*) *subcrenatum* (Carpenter)

Planorbis subcrenatus Carpenter, 1857, Proc. Zool. Soc. London 1856:220. (T. L. Oregon).

Helisoma (*Pierosoma*) *subcrenatum*: Baker, 1945, The Molluscan Family Planorbidae, p. 149, pl. 89, figs. 18-20, pl. 91, figs. 9-15, pl. 92, figs. 1-12, pl. 101, fig.14.

Distribution: California and Utah to Oregon and Washington. Henderson (1936:133) considered this to be the common form of *Helisoma* in Utah.

Occurrence at Fish Springs: Like *Physa virgata*, this is a snail of ponds and marshes. It was not collected in any of the springs or spring outflows but was found only in the semipermanent, shallow pools.

Gyraulus (*Torquis*) *parvus* (Say)

Planorbis parvus Say, 1817, *in* W. Nicholson's British Encyclopedia, 1st American Edition, 2, Article "Conchology," 9th numbered page, pl. 1, fig. 5. (T. L. Delaware River).

Gyraulus (*Torquis*) *parvus*: Baker, 1945, The Molluscan Family Planorbidae, p. 75, pl. 77, figs. 4-6.

Distribution: All of North America from Alaska and northern Canada to Cuba and from the Atlantic to the Pacific (Taylor, 1960: 58).

Occurrence at Fish Springs: Found in all types of habitats. It is well known (Taylor, 1960:58) that *Gyraulus parvus* will tolerate a wide range of environments.

Stagnicola (*Hinkleyia*) *pilsbryi* (Hemphill)

Limnaea (*Leptolimnea*) *pilsbryi* Hemphill, 1890, Natilus 4:25,26. (T. L. "Fish Springs, Nevada").

Galba pilsbryi: Baker, 1911, Chicago Acad. Sci. Special Publ. 3:254,255, pl. 4, figs. A, B.

Stagnicola (*Hinkleyia*) *pilsbryi*: Taylor, Walter, and Burch, 1963, Malacologia 1:237-281, pl. 2, fig. 1.

Stagnicola pilsbryi is known from only three specimens of the original type lot collected by Hemphill in 1868. Taylor et al. (1963) suggest that more specimens were collected but that these additional specimens (if any) were lost.

In all, 134 complete shells and 30 fragmented specimens of this species were collected on the surface of the ground just east of Crater Springs, approximately one-half mile southeast of the refuge headquarters (locality 7, Fig. 2). This area had recently been drained and burned over, and only shells could be found. *Stagnicola pilsbryi* was not found elsewhere in the Fish Springs area.

The sculpture of the shell of *S. pilsbryi* is of spiral incised lines, and fresh shells have raised ridges of periostracum in these incised lines. This characteristic immediately allies this species with *Stagnicola caperata* (Say). Some shells resemble high-spired shells of *Stagnicola montanensis* (Baker), but when comparing adult shells of approximately the same size, *S. pilsbryi* has an additional whorl (Fig. 3).

Measurements: The largest of the three specimens in the type lot of *S. pilsbryi* measured 7.9 mm with 6½ whorls, whereas the largest specimen collected in 1970 measured 16.3 mm with 9 whorls (Table 2). In order to compare adequately *S. pilsbryi* with published measurements of the other two species of *Hinkleyia* (Taylor et al., 1963), 17 specimens were chosen at random from those having over 6 whorls. While the size comparisons are obvious, it is surprising

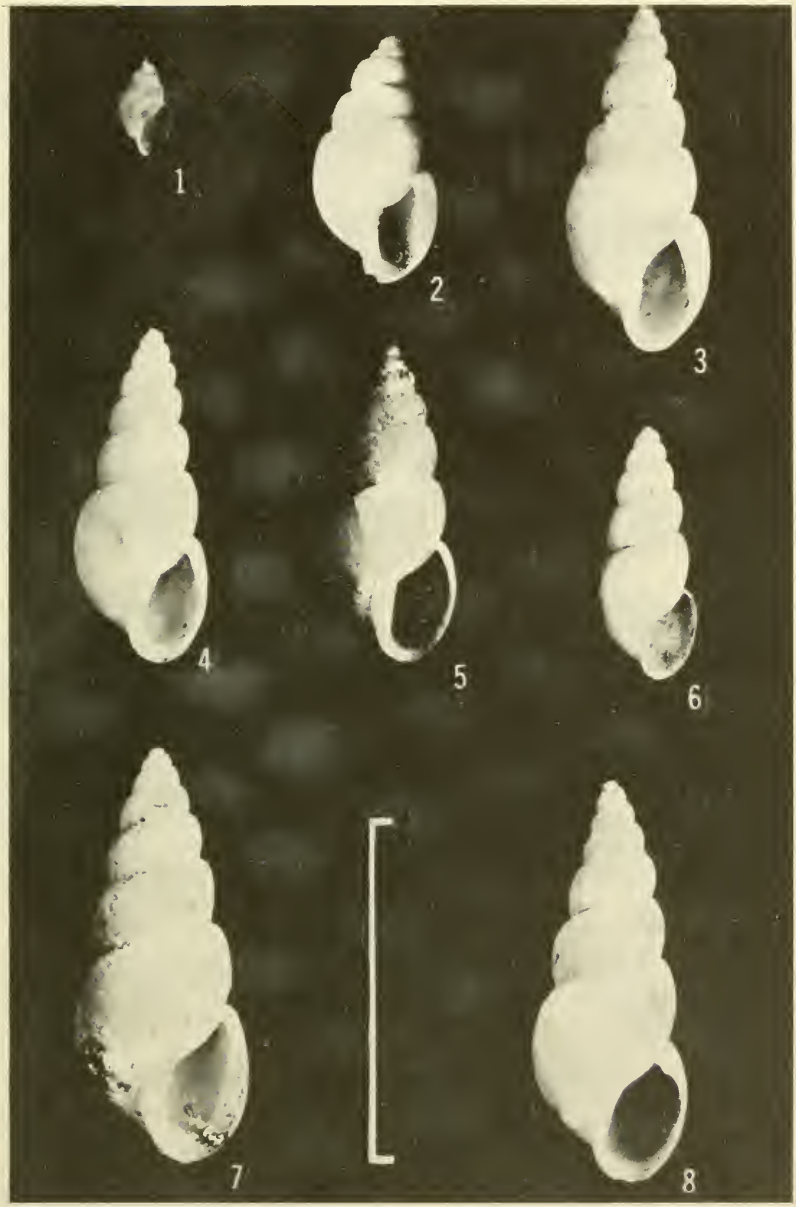

Fig. 3. Shells of *Stagnicola pilsbryi* (Hemphill). Scale line = 10 mm, measurements of length are given. (1) immature specimen of 2.8 mm with 4½ whorls; periostracum intact. (2) 7.5 mm with 6½ whorls; outer surface eroded. (3) 10.6 mm with 7¾ whorls. (4) 9.7 mm with 7½ whorls. (5) 9.7 mm with 7¼ whorls. (6) 7.4 mm with 6½ whorls. (7) 12.3 mm with 8 whorls. (8) 11.8 mm with 8 whorls.

TABLE 2. Shell measurements for *Stagnicola pilsbryi*.

	Shell length	Shell width	Ratio of length to width	Aperture length	Aperture width	Ratio of aperture length to width	No. of whorls
	16.3 mm.	5.9 mm.	2.76	4.9 mm.	3.0 mm.	1.63	9
	15.1	5.2	2.91	4.0	2.9	1.38	9
	14.7	5.6	2.63	4.8	3.1	1.55	8¾
	12.0	4.9	2.45	4.5	3.0	1.50	7½
	11.8	4.5	2.63	4.0	2.8	1.43	7¾
	11.8	4.5	2.63	3.9	2.7	1.44	7½
	11.2	4.9	2.29	4.7	2.9	1.62	7½
	11.2	4.2	2.67	4.0	2.5	1.60	6½
	11.1	4.4	2.52	4.0	2.3	1.74	7
	10.5	4.1	2.56	3.9	2.4	1.62	7
	10.5	4.1	2.56	3.9	2.4	1.62	7
	10.3	4.2	2.45	4.1	2.7	1.52	7
	10.2	4.3	2.37	3.6	2.3	1.57	7½
	9.7	3.8	2.55	3.5	2.2	1.59	7¼
	7.5	3.7	2.03	3.3	2.1	1.57	6¼
	7.4	2.2	3.36	2.8	1.6	1.75	6¼
	7.1	3.3	2.15	2.9	1.8	1.61	6½
Mean	11.1	4.3	2.57	3.9	2.4	1.57	

that the mean ratios of aperture length to width are nearly identical for *S. pilsbryi* and some populations of *S. montanensis* (Table 3).

Habitat: This snail probably occupies a habitat similar to other *Hinkleyia* species. From the location in which the shells were found, it appears that *S. pilsbryi* lives in a shallow, semipermanent marsh. Although burned over, this area was covered with the remains of emergent marsh grasses. In the western United States, *S. caperata* has been found in ponds, marshes, and spring seepages—generally areas with some seasonal fluctuation in water level (Taylor et al., 1963). In a similar manner, *S. montanensis* is typical of ponds, bogs, and marshy creeks. Near the type locality in Montana, I have found it most often in well-drained habitats in mountainous areas.

Laevapex (*Ferrissia*) *californica* (Rowell)

Gundlachia californica Rowell, 1863, Proc. Calif. Acad. Sci.. (1)3:21, 3 figs. (T. L. Feather River, California).

TABLE 3. Comparison of mean shell measurements of *Stagnicola pilsbryi* with other species of *Hinkleyia*.

	Shell			Aperture				
Species	length	width	ratio of length to width	length	width	ratio of length to width	No. of whorls (range)	No. of specimens
S. pilsbryi[1]	11.1	4.3	2.6	3.9	2.4	1.6	6¼ - 9	17
S. caperata[2]	9.8	5.5	1.8	5.2	3.5	1.5	4½ - 5	14
S. montanensis[3]	11.9	5.9	2.0	5.2	3.2	1.6	5¼ - 6¼	22

[1]From Table 2, this paper.
[2]From measurements of specimens collected in western Montana.
[3]Summarized from Table 2, p. 25 in Taylor et al., 1963.

Distribution: Apparently a southwestern species, ranging from Arizona to the west coast. *Laevapex fragilis* (Tryon, 1863) in the west is likely synonymous with *L. californica*. The specific status of eastern and northern (U.S.) limpets referred to *L. fragilis* also remains unsettled.

Occurrence at Fish Springs: Only two shells of *Laevapex* were collected at Fish Springs, and these were in the same general area as shells of *Stagnicola pilsbryi*. This limpet is being referred to *L.* (*Ferrissia*) *californica*, with hesitation, as neither shell is well preserved. Basch (1963) convincingly showed that many species of freshwater limpets are difficult to determine with precision. Chamberlain and Jones (1929:170-171, fig. 79) reported *L.* (*F.*) *rivularis* from Utah Lake, and subsequent authors have repeated this record. No other records of ancylids could be found for Utah.

Ferrissia is typically found in clean water (streams, lakes), and, perhaps, certain of the springs or canals are the habitat at Fish Springs. The occurrence at Fish Springs of a limpet along with other Utah Lake snails (*Physa utahensis*, *Valvata utahensis*) could suggest that the *Ferrissia* at Fish Springs is conspecific with the Utah Lake *Ferrissia*.

Viviparus (*Cipangopaludina*) *chinensis malleatus* (Reeve)

Paludina malleata Reeve, 1863, Conch. Icon., 14, *Paludina*, pl. 5, figs. 25a, b. (T. L. Japan).

Viviparus malleatus: Pilsbry, 1902, Proc. Acad. Nat. Sci. Phila. 54:116, 117, pl. 9, figs. 6, 7.

Distribution: Japan; introduced into U.S. via aquarium trade.

Occurrence at Fish Springs: This species appears to thrive in Middle Spring, near the refuge headquarters. How or when this snail was introduced into the Fish Springs area is not known, but according to refuge personnel, it has been there for some time.

Valvata utahensis Call

Valvata sincera var. *utahensis* Call, 1884, Bull. U.S. Geol. Surv. 11:22, 24, 25, 44, pl. 6, figs. 1-3. (T. L. Utah Lake, Utah).

Valvata utahensis: Bailey and Bailey, 1951, Nautilus 65(2):49, 50, pl. 4, figs. 5, 5a, b.

Distribution: North central Utah. This species is also known as a Pleistocene fossil from California, northern Utah, southern Idaho, and western Wyoming (Taylor, 1966).

Occurrence at Fish Springs: *Valvata utahensis* has been found living primarily in springs. A few individuals of this species have been found elsewhere, but the most favorable habitat seems to be the clean water of the springs, where it lives with *Physa utahensis*. Specimens from Fish Springs show some obvious differences from typical *V. utahensis* in that carinae are absent from both the base and shoulder, and radial striae are coarser than in the typical form.

Tryonia protea (Gould)

Amnicola protea Gould, 1855, Proc. Boston Soc. Nat. Hist. 5:129 (T. L. Colorado Desert).

Tryonia protea: W. G. Binney, 1867, Smithsonian Misc. Coll., 7, Art. 3(144):71, figs. 140, 141.

Distribution: Colorado Desert (southern California), eastern Arizona and southern Utah. Taylor (1966:53-54) has suggested that *Tryonia protea* may actually represent several species.

Occurrence at Fish Springs: This species is generally found living in springs and spring outflows. It should be noted that *T. protea* from Fish Springs was found to be ovoviviparous.

Fontelicella longinqua (Gould)

Amnicola longinqua Gould, 1855, Proc. Boston Soc. Nat. Hist. 5:130. (T. L. Colorado Desert).

Amnicola longinqua: Bailey and Bailey, 1951, Nautilus, 65(2):51, pl. 4, fig. 7.

Distribution: Colorado Desert, Nevada, Utah, southeastern Oregon (Pilsbry, 1899). Chamberlain and Jones (1929:178) indicate that this species is ". . . almost invariably found on watercress near the outflow of springs."

Occurrence at Fish Springs: This species inhabits springs and spring seepages. It lives in every spring examined and was the only snail found living in Cold Spring. This species was placed provisionally in *Fontelicella* by Gregg and Taylor (1965), and the characteristics of the verge (Fig. 4) are as described for the genus. The accessory process is nearly twice the length of the penis, and has

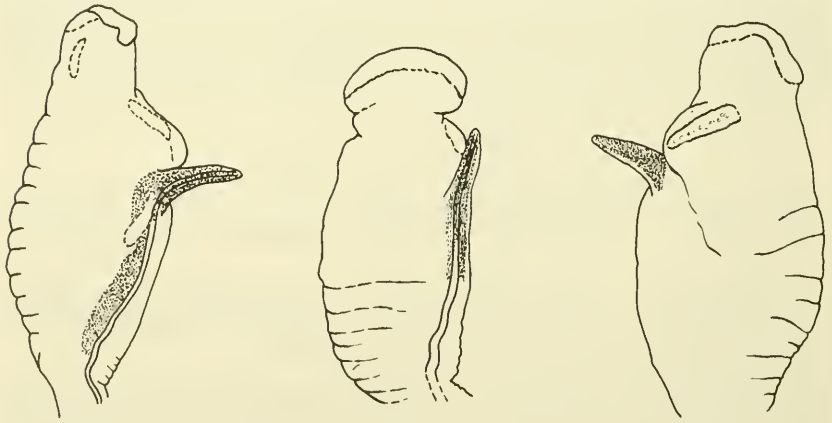

Fig. 4. Verges from three individuals of *Fontelicella longinqua* (Gould) from Cold Spring (locality 1). Scale line = 1 mm.

a conspicuous, raised, circular lobe on the inner surface. This lobe bears an elongate-oval, transverse glandular area. In addition, there is a small glandular area on the verge proximal to the penis and a large glandular area at the distal end of the accessory process (specimens examined were from Cold Spring).

Pisidium insigne Gabb

Pisidium insigne Gabb, 1868, Amer. Jour. Conch., 4(2):69 (T. L., Fort Tejon, Kern Co., California).

Pisidium insigne: Herrington, 1962, Misc. Publ. Museum Zool., Univ. Mich., 118: 42, 43, pl. 6, fig. 5, pl. 7, fig. 21.

Distribution: Nearctic: southeastern and southwestern Canada, northeastern and western U.S.: Utah not included in range (Herrington, 1962).

Occurrence at Fish Springs: Shells of this species were found on the surface of the ground near Mallard Pool. According to Herrington, this is a species of "slow-moving creeks or spring creeks." Neither Henderson (1924, 1936) nor Chamberlain and Jones (1929) lists this species (or any of its synonyms) from Utah.

Discussion

Fish Springs, on the southern edge of the Great Salt Lake Desert, is characterized by a single endemic species. Other species in the area (excepting *Viviparus*) are typical of the Great Basin and the Colorado Desert. Five species (*Oxyloma retusa*, *Physa virgata*, *Helisoma subcrenatum*, *Gyraulus parvus*, and *Pisidium insigne*) are too widespread to be of any special zoogeographic significance.

The distribution of the remaining five species is primarily in the western United States, and two of these species (*Tryonia protea* and *Fontelicalla longinqua*) are well known from the Colorado Desert. *Valvata utahensis* is known primarily as a Pleistocene fossil from California, northern Utah, southern Idaho, and western Wyoming. *Valvata utahensis* and *Physa utahensis* have been collected alive at only a few localities in north and central Utah.

It is conceivable, from an examination of the molluscan fauna, that the Fish Springs area might have been isolated from other Utah waters since the recession of Lake Bonneville in the late Pleistocene. Fish Springs is within the area covered by Pleistocene Lake Bonneville, and it is likely that the distribution of some species of Mollusca in lakes of the Great Basin can be traced to Lake Bonneville. Examples of such species are *Physa utahensis* and *Valvata utahensis*, both well known from Utah Lake (which lies within the basin of Lake Bonneville). It is probable that *Stagnicola pilsbryi* differentiated (as a species) since the last recession of Lake Bonneville. Most of the species found at Fish Springs are known from at least the Pliocene, and, although nothing is known of the history of *S. pilsbryi*, other species of *Hinkleyia* are known from Blancan deposits in the western United States (Taylor et al., 1963).

It is indeed unfortunate that no living animals of *S. pilsbryi* could be found, as the anatomy (and hence the precise taxonomic relationship) is still unknown.

Because of the limited distribution of *S. pilsbryi*, it has been suggested (Taylor et al., 1963) that this snail may have some ecological specialization. My impression is, however, that this is a recently derived species and has a limited distribution only because of extreme isolation. Many of the other molluscan species in the Fish Springs area are of wide distribution, and none appears to have a specialized habitat.

It should be mentioned here that improvements in the Fish Springs area may have unearthed sediments which are Pleistocene or older in age. Some of the shells which were collected may be fossils, but the only species which was not found alive (or as fresh shells) was *Laevapex californica.*

Acknowledgments

I should especially like to thank the staff of the Fish Springs National Wildlife Refuge for their assistance during my visit to the Fish Springs area. In particular, I should like to acknowledge the help of Mr. Ronald Perry, refuge manager at the time of my visit, and Mr. J. Brent Giezentanner, present refuge manager. I should also like to thank Dr. Joseph C. Bequaert and Mr. Peter D'Eliscu for their assistance with the taxonomy and Mr. Richard L. Reeder and Dr. Albert R. Mead for critically reviewing the manuscript. Thanks are also extended to Mr. David Richman and to Miss Laura Emmett for their aid in preparing the figures.

Appendix

Molluscan assemblages in the Fish Springs area. Numbers refer to localities on map (Fig. 2).

1. Cold Spring, 6 miles north of refuge headquarters. (not on map, Fig. 2)
   Fontelicella longinqua (Gould)
2. Middle Spring, at refuge headquarters.
   Physa utahensis Clench
   Gyraulus parvus (Say)
   Viviparus chinensis malleatus (Reeve)
   Valvata utahensis Call
   Tryonia protea (Gould)
   Fontelicella longinque (Gould)
3. Surface of ground near Mallard Pool, 1 mile northeast of refuge headquarters. (shells only)
   Physa utahensis Clench
   Tryonia protea (Gould)

4. Pond near Mallard Pool, 1 mile northeast of refuge headquarters.
   Physa virgata Gould
   Helisoma subcrenatum (Carpenter)

5. Bottom sample from North Spring, 4.5 miles north of refuge headquarters.
   Physa utahensis Clench
   Gyraulus parvus (Say)
   Valvata utahensis Call
   Tryonia protea (Gould)
   Fontelicella longinqua (Gould)

6. Outflow seepage of North Spring, 4.5 miles north of refuge headquarters.
   Physa virgata Gould
   Fontelicella longinqua (Gould)

7. Wet meadow east of Crater Spring, 0.5 mile southeast of refuge headquarters. (Mostly shells on surface of ground)
   Oxyloma cf. *retusa* (Lea)
   Physa virgata Gould
   Helisoma subcrenatum (Carpenter)
   Gyraulus parvus (Say)
   Stagnicola pilsbryi (Hemphill)
   Laevapex californica (Rowell)
   Valvata utahensis Call
   Tryonia protea (Gould)
   Fontelicella longinqua (Gould)
   Pisidium insigne Gabb

8. Canal near Crater Spring (due east of Crater Spring), 0.5 mile southeast of refuge headquarters.
   Physa virgata Gould
   Gyraulus parvus (Say)
   Valvata utahensis Call
   Tryonia protea (Gould)
   Fontelicella longinqua (Gould)

9. Sediment from outlet of South Spring, 0.75 mile southeast of refuge headquarters. Collected 1971 by refuge personnel.
   Physa utahensis Clench
   Gyraulus parvus (Say)
   Valvata utahensis Call
   Tryonia protea (Gould)
   Fontelicella longinqua (Gould)

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ANTS OF THE NATIONAL REACTOR TESTING STATION[1]

Dorald M. Allred[2] and Arthur C. Cole, Jr.[3]

During ecological investigations of ectoparasites in 1966 and 1967 at the National Reactor Testing Station in Idaho, can pit-traps were used to capture small rodents and ground-dwelling arthropods (Allred, 1968). These same techniques, previously used by Allred et al. (1963) from 1960 to 1962 at the Nevada Test Site, were effective for determining species composition and distribution of ants (Cole, 1966). The collections in Nevada extended over approximately 30 months, whereas those in Idaho were conducted for only 15 months. Nevertheless, this latter time was considered adequate to determine the incidence of the majority of kinds of ants and their distribution at the Testing Station in Idaho.

The National Reactor Testing Station is situated in southeastern Idaho, 30 miles west of Idaho Falls. The area of approximately 900 square miles is a level plain with an average elevation of 4,865 ft. The vegetation is characteristic of the cool northern deserts. The most conspicuous plant is *Artemisia tridentata*, but members belonging to *Chrysothamnus*, as well as grasses of several genera, are abundant (Allred, 1968; Atwood, 1970).

Results and Discussion

Ants of 22 species representing 11 genera were collected at the Testing Station during the months of March to November, inclusive (Table 1), although pit-cans were operated continuously. The greatest number of species was taken in June, and the fewest in March. Ants were taken in the greatest abundance in July, whereas the fewest numbers were found in November. Aboveground activity was greatest from May through August.

The greatest number of species was found in study area 2, the fewest in areas 5 and 9 (Table 2). Largest numbers of individuals were taken in areas 1 and 7, whereas the fewest were found in areas 5 and 9.

Ants belonging to *Camponotus vicinus* were the most widespread geographically, although those referable to *Pogonomyrmex owyheei* were the most abundant in numbers of individuals (Table 3). Ants of *Formica obscuripes* and *Veromessor lobognathus* were not widespread geographically but occurred in relatively large numbers. On the other hand, those referable to *F. manni*, *F. subpolita*, and *Myrmica lobicornis* were relatively widespread geographically but occurred in few numbers.

No correlation was evident between plants of a predominant

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TABLE 1. Seasonal, aboveground activity of ants at the National Reactor Testing Station.

Species	Month and number of ants collected								
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Camponotus vicinus		1	32	39	55	9	9	3	2
Formica fusca			2					2	
F. haemorrhoidalis			5	104	12	14	21		
F. hewitti				4					
F. lasioides		1		1	2	2			
F. manni		2	9	2	4	4			
F. montana			2						
F. neogagates		4	2	2	1	3			
F. obscuripes	50					1			
F. obtusopilosa			10	6	7	1		2	
F. oreas		2	5	2	1				
F. subpolita		1	2	3	11				
F. whymperi				2					
Lasius crypticus		7	3		5				3
Leptothorax andrei				1					
Manica mutica						15			
Monomorium minimum				6	116	53	9		
Myrmica lobicornis		5	34	32	3				2
Myrmecocystus mojave			39	10	2	1	1	1	
Pogonomyrmex owyheei			32	65	177	53	26	4	
Tapinoma sessile	5		10	1		1			
Veromessor lobognathus			50	52	27	14			
Total species	2	8	15	17	14	13	5	5	3
Total individuals	55	23	235	332	423	170	66	10	4

species and the number of species or individual number of ants. However, ants of each species do have their own affinities for plant types and edaphic conditions. For example, ants of several species were found where *Artemisia tridentata* was the predominant species of plant, whereas others were found only in a *Chrysothamnus-Artemisia* association. Some ants were associated only with *Elymus* and others with *Juniperus*. Ants representing the greatest number of species were found in the *Artemisia-Chrysothamnus*-grass and *Artemisia* associations, and the fewest were found in the *Juniperus*, *Chenopodium-Eurotia*, and *Oryzopsis-Stipa* associations. Greatest numbers of individuals were found in the *Chrysothamnus-Artemisia*-grass and *Chrysothamnus-Artemisia* associations. Fewest individuals were found in the *Juniperus* and *Chenopodium-Eurotia* areas.

NOTES ON DISTRIBUTION

Cole (1966) listed 53 species of 19 genera in his treatise on the ants of the Nevada Test Site. Rees and Grundmann (1940) listed 18 genera and 56 species, including several subspecies and varieties, known to occur in Utah. Beck, Allred, and Despain (1967) listed 42 species of 17 genera of ants in Utah which they designated as having predaceous-scavenger habits. Twenty-two species of 11 genera are known from the National Reactor Testing Station in Idaho. Only

TABLE 2. Abundance of ants in 12 major study areas at the National Reactor Testing Station.

Species	Study area and number of ants collected											
	1	2	3	4	5	6	7	8	9	10	11	12
Camponotus vicinus	34	13	4			2	24	17		41		7
Formica fusca												2
F. haemorrhoidalis	49	3	97									
F. hewitti		4										
F. lasioides			2				1					
F. manni	1	2					3			12		3
F. montana										2		
F. neogagates		3	8									
F. obtusopilosa									2	20		
F. oreas	7		2									
F. subpolita	2	9					1	3		2		
F. whymperi		2										
Lasius crypticus	8										3	7
Leptothorax andrei					1							
Monomorium minimum	94			26		1		1		2	58	1
Myrmica lobicornis		24	4				27	7		12		1
Myrmecocystus mojave	37		1							14	1	1
Pogonomyrmex owyheei	162	31	2	2		28	47			25	4	54
Tapinoma sessile		1	11									
Veromessor lobognathus		1					141			1		
Total species	9	11	9	2	1	3	7	4	1	10	4	8
Total individuals	394	93	131	28	1	31	244	28	2	131	66	76

half of those known to occur in Idaho also occur at the Nevada Test Site (Table 4). Twenty-six of the species known to occur in Utah also occur in Nevada, but only 8 of these are known from Idaho. Only 3 species that occur in Idaho and Nevada are not known in Utah, and only 8 species are common to all three states. Six species that occur in Idaho and Utah are not known from Nevada.

The difference in numbers of species found at the Nevada Test Site (53), as compared to the National Reactor Testing Station (22), is significant. It may be due, in part, to the length of time spent in collecting—30 months in Nevada and 15 in Idaho. The Nevada site occupied approximately 1,300 square miles at the time of that study, whereas the Idaho site occupied approximately 900. However, these differences are not considered significant enough to account for the difference in the number of species. Furthermore, the Idaho site contained essentially as many different kinds of habitats as the Nevada site, although the elevational extremes were not as great. Consequently, the difference in species composition is likely due to the latitudinal seasonal differences, wherein conditions in southern Nevada are more conducive to ants than in Idaho.

CAMPONOTUS VICINUS.—In Nevada, ants of this species were common in the Pinyon-Juniper community but were not found associated

TABLE 3. Geographic distribution and relative abundance of ants at the National Reactor Testing Station.

Species	No. study areas where found	Total ants collected
Camponotus vicinus	11	150
Pogonomyrmex owyheei	10	357
Monomorium minimum	8	184
Myrmica lobicornis	7	76
Formica manni	5	21
F. subpolita	5	17
Myrmecocystus mojave	5	54
F. haemorrhoidalis	4	156
F. lasioides	3	6
F. neogagates	3	12
F. obtusopilosa	3	26
F. oreas	3	10
Lasius crypticus	3	18
Tapinoma sessile	3	17
Veromessor lobognathus	3	143
F. fusca	2	4
F. hewitti	1	4
F. montana	1	2
F. obscuripes	1	51
F. whymperi	1	2
L. andrei	1	1
M. mutica	1	15

with other vegetative types (Cole, 1966). Beck et al. (1967) found these ants widely distributed in Utah, mostly in *Artemisia* associations. In Idaho these ants were associated with a variety of vegetative types but were most abundant in *Chrysothamnus-Artemisia* associations.

FORMICA FUSCA.—The Pinyon-Juniper community was the only area at the Nevada Test Site where ants of this species were found (Cole, 1966). In Utah few specimens were taken in association with mountain shrub types of vegetation (Beck, Allred, and Despain, 1967). In Idaho the two specimens were taken in a Juniper community.

FORMICA LASIOIDES.—According to Cole (1966), this species is sparsely represented in the Pinyon-Juniper areas at the Nevada Test Site. In Idaho the three specimens were associated with *Elymus* and with *Chrysothamnus-Artemisia.*

FORMICA NEOGAGATES.—These ants were found only in the Pinyon-Juniper community at the Nevada Test Site (Cole, 1966). In Idaho they were associated with the *Artemisia-Chrysothamnus*-grass and *Elymus*-grass communities.

FORMICA OBTUSOPILOSA.—At the Nevada Test Site, the few ants that were found were in mixed vegetative types where scattered junipers and Artemisia were present (Cole, 1966). In Idaho these ants were found in association with *Chenopodium*, *Eurotia*, and *Artemisia.*

TABLE 4. Occurrence of selected species of ants in Nevada, Utah, and Idaho.*

Species	State occurrence		
	Idaho	Utah	Nevada
Camponotus vicinus	+	+	+
Formica fusca	+	+	+
Formica lasioides	+	+	+
F. neogagates	+	+	+
F. subpolita	+	+	+
Lasius crypticus	+	+	+
Monomorium minimum	+	+	+
Myrmecocystus mojave	+	+	+
Formica haemorrhoidalis	+	+	
F. manni	+	+	
F. obscuripes	+	+	
F. oreas	+	+	
F. whymperi	+	+	
Myrmica lobicornis	+	+	
Tapinoma sessile	+	+	
F. obtusopilosa	+		+
Leptothorax andrei	+		+
Veromessor lobognathus	+		+
Crematogaster coarctata		+	+
C. depilis		+	+
Dorymyrmex bicolor		+	+
D. pyramicus		+	+
Formica integroides		+	+
F. limata		+	+
F. microgyna		+	+
F. moki		+	+
F. neorufibarbis		+	+
Iridomyrmex pruinosum		+	+
Leptothorax nevadensis		+	+
Myrmecocystus mexicanus		+	+
Pheidole bicarinata		+	+
P. pilifera		+	+
Pogonomyrmex californicus		+	+
P. occidentalis		+	+
P. rugosus		+	+
Solenopsis molesta		+	+

*Only those species are listed that are known to occur in two or more of the three states.

FORMICA SUBPOLITA.—According to Cole (1966), ants of this species were common but were restricted to the Pinyon-Juniper community at the Nevada Test Site. In Idaho they were found in a variety of plant situations but mostly in the *Artemisia* associations.

LASIUS CRYPTICUS.—Cole (1966) reported that ants of this species occur in association with Pinyon-Juniper in Nevada. In Utah these ants were associated primarily with mountain-shrub type vegetation (Beck, Allred, and Despain, 1967). In Idaho they were most common in *Chrysothamnus* and Juniper areas.

LEPTOTHORAX ANDREI.—At the Nevada Test Site, only a few specimens were found, and these were in association with the Pinyon-Juniper community (Cole, 1966). The single specimen taken in Idaho was in a Juniper community.

Monomorium minimum.—At the Nevada Test Site, ants of this species were found chiefly in *Coleogyne* and mixed communities, although a few scattered colonies were seen in the Pinyon-Juniper community (Cole, 1966). In Utah these ants were predominantly in areas typified by pinyon and juniper (Beck, Allred, and Despain, 1967). In Idaho they were associated with a variety of plants but were found most commonly where *Chrysothamnus* and grass were abundant. Few were found in the Pinyon-Juniper association.

Myrmecocystus mojave.—At the Nevada Test Site, ants of this species were restricted to the Pinyon-Juniper areas (Cole, 1966). In Utah few specimens were found associated with *Artemisia* (Beck, Allred, and Despain, 1967). In Idaho these ants were associated with a variety of plants, mostly *Chrysothamnus* and *Artemisia*.

Veromessor lobognathus.—Formerly considered rare, ants of this species are common occupants in certain areas, and records are known for Colorado, Nevada, North Dakota, and South Dakota (Cole, 1966). At the Nevada Test Site, nests were largely confined to Pinyon-Juniper areas, mainly under or adjacent to large rocks. In Idaho, ants of this species were most abundant in the *Chrysothamnus-Artemisia* association.

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NEW RECORDS AND SPECIES OF AMERICAN PLATYPODIDAE (COLEOPTERA)[1]

Stephen L. Wood[2]

On the following pages 12 species of *Platypus* (Platypodidae: Coleoptera) are described as new to science. Of these, 2 occur in Colombia, 8 occur in Venezuela, 1 was taken in both Colombia and Venezuela, and 1 is from both Panama and Costa Rica. Notes are also included on the species group Platypi filiformes of Chapuis and on the synonymy of *Platypus disciporus* Chapuis from the southeastern United States.

Group Platypi filiformes

Chapuis (1865, Monographie des Platypides, p. 217) established the Platypi filiformes to include his species *Platypus sallei*, *macroporus* and *quadrispinatus*, from Colombia, and *disciporus* from Tennessee. The latter species is transferred from the group below. Later, Schedl (1936, Rev. Française Ent. 2:245) named *complatinus* (spelled *complanatus* on p. 242 and in subsequent usage) and established the group Platypi complanati (in litt.) to contain it and allied forms, including *annexus* Wood, *eugestus* Wood and *vegestus* Wood. On the following pages, eight additional species are described which, in my opinion, completely bridge the gap between the Platypi filiformes and the Platypi complanati. It is also noted that male *annexus* also have a median tubercle on the last visible abdominal sternum as in *armatus* Chapuis, which, with other characters found in the group, eliminates the necessity for maintaining the Platypi bicornuti as a separate group.

Platypus nudatus, n. sp.

This species is very closely related to *pernudus* Schedl; but it is distinguished by the more finely granulate frons; by the less shining, less distinctly punctured pronotum; and by the less strongly elevated, much less coarsely serrate declivital interstriae in the male.

Male.—Length 2.8 mm (paratypes: males 2.6-2.8 mm, females 2.7-2.9 mm), 3.3 times as long as wide; color dark brown.

Frons, pronotum, and elytral disc as in *pernudus* except frons much more finely granulate, punctures less clearly defined, pronotum less shining, more finely punctured. Elytral declivity as in *pernudus* except interstriae less acutely elevated, much less strongly serrate, with fewer serrations on each interstriae.

Female.—Frons and pronotum as in male; elytra as in female of *pernudus* except declivital face rugulose-reticulate and with fewer granules on lower half.

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Type Locality.—Eight km S Colonia (near Buenaventura), Valle de Cauca, Colombia.

Type Material.—The male holotype and four paratypes were taken at the type locality on 9 July 1970, 30 m elevation, No. 613, from *Couma macrocarpa*, by S. L. Wood; paratypes bear identical data except that five and the female allotype are No. 615 from *Lecythis* sp., and eight are No. 606 from *Sacoglothis procera*.

The very close anatomical similarity and the allopatric distributions of these two forms suggest recent speciation or possible subspecies. This question can be answered only by additional collecting.

The holotype, allotype, and paratypes are in my collection.

Platypus applanatus, n. sp.

This species is in the Platypi filiformes group very closely related to *complanatus* Schedl; but it is distinguished by the less strongly reticulate, more strongly punctured frons in both sexes; by the more strongly impressed and pubescent female frons; by the smaller strial punctures; and by minute differences in the sculpture of the male declivity.

Male.—Length 2.5 mm (paratypes: males 2.5-2.6 mm, females 2.7 mm), 3.7 times as long as wide; color brown.

Frons as in *complanatus*, but much less strongly reticulate, punctures larger, slightly deeper. Antennal scape similar. Pronotum very slightly more slender; surface obscurely subreticulate, punctures smaller, less distinct; pores similar.

Elytral basal margins variable in series, weakly carinate or not; striae 1 weakly impressed anteriorly, narrowly sulcate on posterior half, others not impressed except sulcate near declivity, punctures small, shallow, many obsolete; declivity almost exactly as in *complanatus* except interstriae less acutely elevated, interstriae 3 converging very slightly toward suture, apical denticle on costal margin closer to suture than to posterolateral angle.

Female.—Frons and pronotum as in male, not at all like *complanatus;* elytra as in female *complanatus* except strial punctures greatly reduced.

Type Locality.—Thirty km E Palmar, Bolivar, Venezuela.

Type Material.—The male holotype, female allotype, and nine paratypes were taken at the type locality on 6 June 1970, 200 m elevation, No. 540, from *Pouteria egregia*, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Platypus deceptor, n. sp.

This species is allied to *applanatus* Wood, described above; but it is distinguished by the larger size; by the steeper male elytral declivity; by the presence of pronotal pores only in the female; and by differences in sculpture of the male declivity.

Male.—Length 3.5 mm (paratypes: males 3.5-3.8 mm, females 3.8-4.0 mm), 4.1 times as long as wide; color dark brown.

Frons as in *applanatus* except broadly, weakly impressed, punctures smaller. Scape similar. Pronotum outline as in *applanatus;* surface irregularly reticulate, punctures small, shallow, rather abundant but irregular in size and density; pores absent.

Elytral disc as in *applanatus* except striae more distinctly impressed, punctures slightly larger, deeper, more regularly spaced; interstriae anterior to but near declivital base equally convex, 2, 4, 5, and 6 decreasing in width and height more rapidly than others, obsolete before middle, 1 and 3 slightly higher than others, ending at middle, lower half steeper and without definable striae or interstriae; posterolateral angles acute (about 85 degrees), not produced, lateral margin serrate; apical costal margin with a subdentate process in line with interstriae 2 (somewhat as in *pernudus*). Vestiture scanty, as in allied species.

Female.—Frons and pronotum as in male except a pair of very large pores just behind middle of pronotum and behind these a tuft of about a dozen moderately long, hairlike setae; elytra as in female *applanatus* except strial punctures larger, deeper, and declivital face with several granules.

Type Locality.—La Carbonera Experimental Forest, about 50 km (airline) W Merida, Venezuela.

Type Material.—The male holotype, female allotype,, and 21 paratypes were taken at the type locality on 9 December 1969, 2500 m elevation, Nos. 171 and 176, by S. L. Wood, from unidentified logs; other paratypes taken at the same locality, by the same collector include: 13 on 16 October 1969, No. 21, *Prunus spaerocarpa*, and three, Nos. 19 and 20, *Ficus;* two on 10 November 1969, No. 123; 12 on 23 April 1970, No. 450; four on 14 October 1969, No. 56, *Nectandra* sp.; two on 14 November 1969, No. 66. One paratype is from La Mucuy Experimental Forest, 20 km E Merida, Merida, Venezuela, 20 October 1969, 2500 m., No. 74, S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Platypus deplanatus, n. sp.

This species is in the Platypi filiformes near *applanatus*, described above; but it is distinguished by the slightly impressed, strongly reticulate frons with coarse, round punctures; by the much more coarsely punctured pronotum; by the larger, deeper, interstrial punctures; and by the sculpture of the male declivity.

Male.—Length 3.1 mm (paratypes: males 3.0-3.2 mm, females 3.3-3.4 mm), 4.3 times as long as wide; color light brown.

Frons as in *applanatus* except very slightly, broadly impressed, less irregular, surface strongly reticulate; punctures moderately large, sparse, rather deep. Scape as in *applanatus*. Pronotum outline as in *applanatus*, pores slightly larger, surface smooth, shining, with abundant small punctures of irregular size and spacing. Elytral disc as in *applanatus* except punctures slightly larger and deeper; declivity slightly shorter and less strongly declivous than in *ap-*

planatus; interstriae 1 and 3 subcarinate and moderately elevated to middle of declivity, one or two minute granules near apex of each, 2, 4-7 obsolete at or near base, apical area rugose-reticulate; sutural apex slightly divaricate, costal margin in line with interstriae 2 slightly produced, not dentate; posterolateral angle (dorsal aspect) acutely pointed (about 70 degrees), feebly produced, as seen from posterior aspect lateral angles well below level of median prominences; lateral margin of declivity (dorsal aspect) coarsely serrate.

Female.—Frons and pronotum as in male; elytra as in female *applanatus* except strial punctures slightly larger, deeper, declivity shorter and not as steep on basal half, steeper on lower half, surface of lower half more strongly rugose-reticulate, small granules slightly larger than in *applanatus*.

Type Locality.—La Carbonera Experimental Forest, about 50 km (airline) W Merida, Merida, Venezuela.

Type Material.—The male holotype, female allotype, and five paratypes were taken at the type locality on 16 September 1970, 2500 m elevation, No. 21, from *Prunus sphaerocarpa*, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Platypus filaris, n. sp.

This species definitely is allied to *deplanatus* Wood, described above, but it is much more closely related to *sallei* Chapuis. It is distinguished from the description of *sallei* (specimens not seen) by the flattened, more finely sculptured frons, by the equally carinate lateral interstriae near the declivity, and, evidently, by the more finely punctured pronotum. As in *sallei*, only the female has a pair of large pronotal pores.

Male.—Length 3.0 mm (paratypes: males 2.8-3.1 mm, females 3.0-3.3 mm), 4.0 times as long as wide; color brown.

Frons broadly flattened from epistoma to above eyes, a slight transverse impression just below level of antennal insertion; surface shining below level of antennal insertion, rugose-reticulate above, punctures fine and obscure above, fine and moderately coarse intermixed below. Scape as in *complanatus*. Pronotum outline as in *deplanatus*, surface almost smooth except obscurely subreticulate at anterior and posterior extremities in most specimens, punctures fine, shallow, sparse, largely confined to basal half; pores absent.

Elytral outline much as in *deplanatus* but more truncate posteriorly; disc as in *deplanatus* except strial punctures smaller, many obsolete; upper declivital area not at all declivous, striae 1 narrowly sulcate on posterior two-thirds of elytra, 2 sulcate on posterior third, others a lesser portion; interstriae 2 and 4-8 on declivital area narrowly convex, decreasing in width and obsolete just before apex except 2 ending well before apex, 1 and 3 weakly elevated and reaching apex, 3 continued as a costa to posterolateral angle, 1 projecting very slightly; subvertical lower declivity rugose-reticulate,

apical margin in line with striae 2 armed by a coarse process, viewed from posterior aspect apices of these processes and posterolateral angles in a straight line; posterolateral angles from dorsal aspect acutely pointed (about 70 degrees), very slightly produced; lateral margin of declivity coarsely serrate.

Female.—Frons and pronotum as in male except pronotum with a pair of large pores near median line just behind middle, a small tuft of hair immediately behind each pore; elytra as in female *deplanatus* except strial punctures greatly reduced in size and number.

Type Locality.—Rancho Grande in Pittier National Park, Aragua, Venezuela.

Type Material.—The holotype, allotype, and six paratypes were taken at the type locality on 9 April 1970, 110 m elevation, No. 444, from a small tree, by S. L. Wood. Other paratypes bear the same locality, date, and collector data but differ as follows: six are No. 512 from an unidentified large tree; two are No. 454 from *Eschweilera* sp.; and one is No. 428 from *Tabebuia* sp.

The holotype, allotype, and paratypes are in my collection.

Platypus spectus, n. sp.

This species is allied to *filaris* Wood, described above, but it is distinguished by the larger size and by the much more strongly developed characters on the elytral declivity.

Male.—Length 3.8 mm (paratypes 3.6-3.8 mm), 4.0 times as long as wide; color brown.

Frons, scape, and pronotum as in *filaris* except pronotal surface with a few more fine punctures and many more impressed points. Elytral disc as in *filaris;* declivital area on level with disc, not descending at all, with interstriae 2, 4, and 6 narrowed and obsolete before apex, others weakly convex, 1 and 3 feebly elevated, 1 projecting beyond sutural apex in a blunt spine as long as wide, 3 projecting an equal distance and continued as a straight costa to posterolateral angles, angles subacute (about 80 degrees), lateral margins of declivital area serrate, about five denticles seen from dorsal aspect; lower part of declivity below spine and costa excavated, subvertical; costal margin at sutural apex transversely straight on slightly less than median half, then continuing caudoventrad to a blunt process just mesad of posterolateral process, these two processes separated by a small, shallow notch.

Female.—Frons and pronotum as in male except pronotal surface more nearly subreticulate, and a pair of large pores present in usual position, a small tuft of hairlike setae immediately posterior to each pore; elytra as in female *filaris* except strial punctures slightly larger, and vertical face of declivity somewhat smoother and with finer granules.

Type Locality.—Rancho Grande in Pittier National Park, Aragua, Venezuela.

TYPE MATERIAL.—The male holotype, female allotype, and three male paratypes were taken at the type locality on 9 April 1970, 1100 m elevation, No. 418, from the bole of a dying tree, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Platypus eximius, n. sp.

This species clearly is allied to *vegestus* Wood, but it is distinguished by the larger size, by the more finely sculptured pronotum, with pronotal pores absent in the male, and by the very different sculpture of the male declivity.

MALE.—Length 4.3 mm (paratypes 4.2-4.4 mm), 4.3 times as long as wide; color dark brown.

Frons as in *vegestus* except very slightly impressed toward median area, punctures smaller, not as deep. Pronotum outline as in *vegestus*, surface almost smooth except near anterior and posterior margins, rather numerous minute points and a few small punctures present, major pores absent. Elytral disc as in *vegestus;* posterior declivital processes weakly declivous, strongly produced, each subquadrate as seen from dorsal aspect, almost as long as wide, inner apical angle rounded, outer angle subacute, emargination between processes slightly wider than half width of a process, subquadrate; lateral margins of declivital area weakly serrate; dorsal surface of declivital area rugose-reticulate except on definable interstriae.

FEMALE.—Frons and pronotum as in male except pronotal pores present, surface of pronotum more nearly subreticulate; elytral surface as in male, elytral form as in female *eugestus* Wood.

TYPE LOCALITY.—Colonia Tovar, Aragua, Venezuela.

TYPE MATERIAL.—The male holotype, female allotype, and six male paratypes were taken at the type locality on 4 May 1970, 1700 m elevation, No. 503, from a log 1 m in diameter, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Platypus secus, n. sp.

This unique and specialized species might possibly be allied to *eximius* Wood, described above, but the relationship is not close.

MALE.—Length 3.6 mm (paratypes: male 3.5-3.7 mm, females 3.8-4.0 mm), 3.4 times as long as wide; color dark brown except most of basal three-fourths of elytra pale yellowish brown.

Frons rather shallowly, broadly impressed from epistoma to slightly above upper level of antennal insertion, flattened above; surface subreticulate, rugulosely marked by large, shallow punctures of irregular shape, centers of punctures also with fine rugae; each margin of frons around and below mesal margin of antennal insertion marked by a fine, low carina. Scape as in *complanatus*.

Pronotum outline as in *complanatus;* surface subrugulose, with fine, rather sparse punctures on anterior two-thirds, posterior third

in median area more coarsely, closely punctured, some of them moderately strigose.

Elytral bases not at all carinate; striae 1 slightly sulcate posteriorly, others not at all impressed, punctures almost obsolete except larger toward declivity; interstriae very smooth, shining; sides on posterior third arcuately narrowed to base of posterior sixth to one-half widest elytral width, posterior sixth with sides almost parallel to truncate apex, median line of terminal process narrowly, rather deeply cleft; strial punctures obsolete on declivital process, fine shallow punctures apparently of interstrial origin present. Ventral areas of declivity about as in *eximius* except a blunt tubercle present near apex of suture.

Female.—Frons as in male except small central area almost smooth, more than median half on a slightly procurved line at lower level of antennal insertion precipitously, not strongly, impressed, lower area as in male; pronotum and elytral disc as in male; declivity about as in female *spectus*, but shorter.

Type Locality.—La Carbonera Experimental Forest, about 50 km (airline) W Merida, Merida, Venezuela.

Type Material.—The male holotype and 11 paratypes were taken at the type locality on 14 November 1969, 2500 m elevation, No. 60, from a *Nectandra* log, by S. L. Wood; of 61 paratypes from the same locality, date and collector, 3 are No. 55 from *Eschweilera* sp., the others are from various unidentified hosts; 3 paratypes were taken at the same locality on 12 January 1970, No. 235, from *Podocarpus raspigliosii* logs. Seven paratypes were taken at Colonia Tovar, Aragua, Venezuela, on 4 May 1960, 1700 m elevation, No. 507, from an unidentified log, by S. L. Wood.

This species occurred in epidemic numbers at the type locality where logging was in progress. Three healthy, isolated trees left standing in the logged area were attacked and killed at the height of the epidemic. About six months later this species was again rare in the area.

The holotype, allotype, and paratypes are in my collection.

Platypus quadridentatus (Olivier)

Scolytus quadridentatus Olivier, 1795, Entomologie ou Histoire Naturelle des Insectes, Coleoptera 4(78):5 (Amerique septentrional).

Platypus disciporus Chapuis, 1865, Monographie des Platypides, p. 219 (Holotype, female; Tennessee). *New synonymy.*

Although female specimens assigned to *disciporus* Chapuis and males assigned to *quadridentatus* (Olivier) have been taken at many localities in the southeastern United States from *Quercus* logs, synonymy has never been suggested because the female, with a pair of very large pronotal pores, and the male, with none, have not been taken from the same tunnels. Recently a large series of males and females were examined which had been reared from a section of an oak log. Since no other platypodids were present and because

no other species occur in the southeastern United States that could possibly enter into this problem, *disciporus* Chapuis is placed in synonymy under *quadridentatus* (Olivier).

This species belongs to the Platypi bilobati.

Platypus sicarius, n. sp.

This is the smallest and most conservatively sculptured species of the Platypi bilobati known to me. It is somewhat allied to *prenexus* Wood; but it is distinguished by the presence of a pair of pronotal pores in both sexes; by the short, vertical, elytral declivity of the male; by the different sculpture of the male declivity; and by the much smaller spines on male abdominal sternum 3.

Male.—Length 2.0 mm (paratypes 1.9-2.1 mm, both sexes), 4.0 times as long as wide; color light brown.

Frons almost flat from epistoma to upper level of eyes; surface almost smooth below level of antennal insertion, reticulate above; punctures on median two-thirds coarse, rather deep, moderately close. Antennal scape 1.5 times as long as wide, widest on basal third.

Pronotum outline as in *prenexus;* a pair of rather small pores near median line one-third pronotum length from base; surface almost smooth except subreticulate near base, punctures very small, shallow, rather sparse. Almost glabrous.

Elytral bases not carinate; striae not impressed, punctures rather small, distinctly impressed; interstriae wider than striae, 1 weakly carinate on posterior two-thirds, 3 on posterior third, 5 and, to a lesser degree, 7 near declivity, 2 and 4 depressed and obsolete near declivity; posterior fourth weakly declivous and minutely rugulose, with shining carinae of interstriae 1 and 3 gradually declining and ending just before declivity, 5 and 7 end anterior to this point; truncate behind, short declivity vertical; posterolateral angle subacute (about 85 degrees), feebly projecting, costal margin anterior to angle with about four or five rather coarse serrations; from posterior aspect, apical margin of declivity forms a straight line between lower margins of posterolateral angles. Vestiture of rather abundant hair on and near declivity.

Female.—Frons and pronotum as in male; elytral bases subcarinate on median half, base of interstriae 3 with several transverse crenulations; striae and strial punctures almost obsolete except for subsurface markings; interstriae 1 and 3 weakly elevated near declivity; declivital area simple, without carinae or acute lateral angles, margin somewhat rounded, vertical behind, devoid of granules.

Type Locality.—Ten km SE Miri, Barinas, Venezuela.

Type Material.—The male holotype, female allotype, and nine paratypes were taken at the type locality on 8 February 1970, 150 m elevation, No. 301, from *Pouteria anibaefolia*, by S. L. Wood.

Four paratypes are from 40 km E Canton, Barinas, 8 March 1970, 70 m, No. 342, from the same host and collector.

The holotype, allotype, and paratypes are in my collection.

Platypus querceus, n. sp.

This species is very closely related to *biporus* Blandford, but it is distinguished by the smaller size, by the distribution, by the armature of the male declivity, and by other characters indicated below.

MALE.—Length 3.3 mm (paratypes 3.2-3.4 mm, both sexes), 4.4 times as long as wide; color dark brown, elytra lighter in color.

Frons as in *biporus* except less strongly convex, slightly less rugose. Pronotum as in *biporus* except more finely, less closely punctured. Elytral disc as in *biporus* except striae less strongly impressed; declivity similar to *biporus* except interstriae 1 with four or five small uniseriate tubercles, 3 more narrowly elevated, its summit armed by about five small granules, its apex descending slightly and projecting but not reaching level of sutural apex; lateral prominences similar to *biporus*, broader at their apices than at their bases, distance between apices less than between bases, distance between apices only slightly greater than transverse width of a process; serration on costal margin of declivital area much coarser than in *biporus*.

FEMALE.—Frons, pronotum, and elytral disc differing from female *biporus* as in males; elytral declivity more simply, more finely sculptured than female *biporus*.

TYPE LOCALITY.—Volcan de Chiriqui (near Cerro Punta), Chiriqui, Panama.

TYPE MATERIAL.—The male holotype, female allotype, and three paratypes were taken at the type locality on 11 January 1964, 1900 m elevation, No. 373, in *Quercus*, by S. L. Wood. Five paratypes are from 10 km SE Cartago, Cartago, Costa Rica, 3 July 1963, 1900 m, No. 16, same host and collector; two paratypes are from Tapanti, Cartago, Costa Rica, 2 July 1963, 1300 m, No. 6, same host and collector.

The holotype, allotype, and paratypes are in my collection.

Platypus eversus, n. sp.

This species is very closely related to *schedli* Wood (in all probability *schedli*, 1966, = *tiriosensis* Reichardt, 1965, = *araucariae* Schedl, 1966), but it is distinctly larger, it has the frons more strongly impressed, and the male declivity differs as indicated below.

MALE.—Length 3.2 mm (paratypes 3.0-3.4 mm), 3.4 times as long as wide; color dark brown, anterior half of elytra usually lighter.

Frons as in *schedli* except more broadly, more strongly impressed from epistoma almost to upper level of eyes, sculpture similar but not as coarse. Pronotum as in *schedli* except sculpture near base

somewhat finer. Elytra as in *schedli* except crenulations at base of interstriae 3 larger and more numerous; carinae on interstriae 1, 3, and 5 slightly higher, 1 and 3 not projecting; processes on costal margin near suture much wider and of a slightly different shape, process forming posterolateral angle of declivity stouter, summit of carina slightly longer.

Female.—Frons, pronotum, and elytral disc as in male; elytral declivity as in female *schedli*.

Type Locality.—Eight km south of Colonia (near Buenaventura), Valle de Cauca, Colombia.

Type Material.—The male holotype, female allotype, and 23 paratypes were taken at the type locality on 9 July 1970, 30 m elevation, No. 611, from a *Lecythis* sp. by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Platypus pouteriae, n. sp.

This species is in the Platypi declivi of Chapuis, 1865, near *Platypus laticollis* Chapuis, but it is distinguished by the much smaller size, by the more nearly carinate interstriae on the posterior third of the disc, and by the serrate interstriae 9 at base of declivity; the punctures on the discal striae are very shallow, unusually large, and of irregular shape; and the declivital striae are obsolete in the lateral areas.

Male.—Length 2.3 mm (paratypes: males 2.2-2.4 mm, females 2.7-2.9 mm), 2.7 times as long as wide; color dark brown.

Frons shallowly, broadly impressed from epistoma almost to upper level of eyes; surface weakly reticulate, punctures large, shallow, irregular in size, shape and spacing, a few confluent. Antennal scape almost eliptical in outline, very slightly narrower toward apex.

Pronotum outline as in *obtusus;* surface minutely punctulate on anterior fourth, becoming shallowly subreticulate posteriorly, punctures small, shallow, sparse. Glabrous except near margins.

Elytral outline as in *obtusus* except somewhat more narrowly rounded behind; basal carina as in *obtusus;* striae not impressed on basal third, then gradually impressed until moderately deep at base of declivity, punctures very large, irregular in shape, very shallow; interstriae equally developed, not at all convex on basal third, gradually increasing in convexity until subcarinate at base of declivity, about half as high as wide at highest point; remnant of interstriae 10 with about four feeble serrations; base of 3 with about five narrow tubercles. Declivity broadly convex, steep; surface rugose-reticulate; strial impression decreasing in depth until obsolete before middle except 1 and 2 narrowly, shallowly impressed to near apex, punctures not clearly defined; lateral areas on lower half with shallow, obscure punctures in indefinite rows; base of 9 with about three moderately large tubercles. Vestiture confined to declivity, of stout, rather short bristles in strial and interstrial rows toward base, con-

fused toward apex; moderately abundant. Last visible abdominal sternum much less inflated than in *obtusus*.

Female.—Frons shallowly, broadly concave on lower two-thirds, surface smooth, with a few minute punctures; scape and pronotum as in male; elytra as in female *obtusus* except all punctures much smaller and tubercles at base of interstriae 3 and on declivity much smaller.

Type Locality.—Forty km southeast of Socopo, Barinas, Venezuela.

Type Material.—The male holotype, female allotype, and 39 paratypes were taken at the type locality on 25 January 1970, 150 m elevation, No. 260, from *Pouteria anibaefolia*, by S. L. Wood. Seven paratypes are from 30 km N Cañon Zancudo, Zulia, Venezuela, 4 June 1970, 10 m, No. 517, same host and collector; 13 paratypes are from 8 km S Colonia (near Buenaventura), Valle de Cauca, Colombia, 9 July 1970, 30 m, No. 619, from *Pouteria*, by me.

The holotype, allotype, and most of the paratypes are in my collection; two paratypes are in the Schedl Collection.

THE SNAKE GENUS *AMASTRIDIUM* IN OAXACA, MEXICO

Hobart M. Smith[1]

In their excellent review of the snake genus *Amastridium*, Wilson and Meyer (1969) reported specimens from but four states of Mexico: Nuevo León, Tamaulipas, Veracruz, and Chiapas. A specimen (Univ. Colo. Museum 39895) taken by Thomas MacDougall, 17 March 1969, at Las Muellas, Palomares, Juchitán, Oaxaca, bridges the gap between Atlantic-slope specimens northward from the Isthmus of Tehuantepec and the Pacific-slope individuals from southern Chiapas.

The specimen is a small female, 225 mm total length, 56 mm tail length, with loreals 1-1, supralabials 7-7, infralabials 9-9, maxillary teeth 15 + 2 (enlarged rear teeth not grooved), postoculars 2-2, temporals 1-2, ventrals 162, caudals 80, anal divided, no scale pits except on nape. The color is almost uniformly dark above and below, with a large pinkish spot on the nape extending forward into the parietal area on each side.

In all these respects the specimen is typical of the northern populations characterized by Wilson and Meyer. Their conclusion that the genus is monotypic, however, is open to question. Their evidence that populations from Nicaragua to Panama are closely related to those occurring northward from Honduras, and that they do not differ in some respects (*e.g.*, grooving of maxillary teeth) previously suggested, is completely convincing and irrefutable. There is likewise an apparent cline in the number of ventrals northward from Honduras. Nevertheless there is a hiatus of considerable magnitude in the number of ventrals between populations northward from Honduras, including the male reported by McCoy (1971:136) from Middlesex, British Honduras (males, 146-158; females, 144-170) and those to the south (males, 119-129; females, 126-134). The data reveal a hiatus in character-states also between Honduras (males, 146; females, 144) and more northern localities (males, 150-158; females, 152-170), but it is of lesser magnitude, involves fewer specimens, and is therefore likely an artifact of inadequate sampling and is unsupported by correlated distinctions. The Honduras-Nicaragua hiatus *is* correlated with another distinction (loreal present to the north, absent to the south) and is supported by sufficient series to lend considerable confidence in the reality of the indicated differences. Moreover, a range of 32-35 in ventral counts in a single taxon with so few ventrals is exceptional. A geographic segregation in character-variation of systematic magnitude does exist in the data now available, yielding a 100 percent separation of the compared populations on the basis of two independent criteria. Taxonomic

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recognition of this fact is mandatory even if reliance is to be placed upon anticipated evidence yet to come.

To be sure, a great deal of taxonomy among poorly known populations is guesswork, for incontrovertible proof is provided only by large samples from closely adjacent but widespread localities. Even then, taxonomic conclusions may be moot, since even full data may on occasion reasonably be interpreted differently by different experts. Yet it is a systematist's duty to make the best educated guess he can of the populational relationships and characteristics that exist in nature, however inadequate the data.

In the present case, one may justify a guess that populations in the Honduras-Nicaragua hiatus either do not exist or are reproductively isolated, in either case requiring recognition of two species; or one may justify assumption of continuity and intergradation of the two populations, requiring recognition of two subspecies delimited by a strong, doubly augmented step in clinal variation in at least two characters. It seems inconceivable to conjecture that further data would justify the conclusion that in no character will a strong clinal step, or hiatus, prove to exist; yet that conjecture would have to be made to justify recognition of only one taxon in *Amastridium*.

Accordingly, the data now known require recognition of both *veliferum* and *sapperi;* the guess is here made that they will prove to interbreed in a zone of contact, resulting in an intergradation of differential characteristics. It is therefore suggested that the members of this genus be designated as *Amastridium veliferum veliferum* Cope, 1861, and *Amastridium veliferum sapperi* (Werner, 1903). To the latter subspecies belongs the specimen here recorded from Oaxaca.

Dr. Wilson kindly provided data on an additional specimen of *Amastridium*, here referred to as *A. v. sapperi*, which he encountered after his review of the genus appeared. It is Univ. Arizona 27036, 2 mi (3 km) SE Sontecomapán, 14 mi (22 km) NE Catemaco, Veracruz, taken 23 Aug. 1967; exasperatingly it is another female; ventrals 154, anal divided, caudals 72; 17 scalerows throughout; loreals 1-1, supralabials 7-7, infralabials 9-9, oculars and temporals 1-2; total length 450 mm, tail 106 mm. The locality is blanketed by previous records.

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RARE ABERRANT FORMS OF UTAH CYNTHIA: THE PAINTED LADY (LEPIDOPTERA: NYMPHYLIDAE)

W. Levi Phillips[1]

The butterflies and moths of Utah have always attracted the attention of students of nature and are therefore usually the first group of insects studied by beginning students of entomology. As a result of this and of the activity of several amateur lepidopterists, a rather complete collection of Utah Lepidoptera is now contained in the Brigham Young University collection.

In 1902 Chester Van Buren, who was a naturalist on the Harvey Cluff expedition to South America, made a small collection of Central American and Colombian Lepidoptera. These formed the nucleus of the university Lepidoptera collection. In 1930 the Tom Spalding collection of the Utah Lepidoptera was purchased. Mr. Spalding had spent many years collecting Lepidoptera in various parts of Utah and had accumulated more than 500 species. In 1940 Dr. L. D. Foutz, a dentist and amateur naturalist of Payson, Utah, contributed his collection of 63 species and 730 specimens. Fourteen topotypes of *Argynnis pfoutsi* Gunder were included in the Pfoutz collection.

During World War II, Dr. D Elden Beck, on leave from the university and as a captain in the army, was stationed in the Solomon Islands. He and several Brigham Young University students deposited many Lepidoptera from areas of the South Pacific Islands in the university collection.

In 1960 the Ashby B. Boyle collection of Lepidoptera was contributed to the university by Mrs. Boyle. This valuable collection contains 450 determined species of butterflies and moths. Mr. Boyle was very careful in his preparation of the specimens. These, along with collections made by staff members of the department over the past 40 years, make up a rather sizeable and valuable collection of the native Lepidoptera of the Great Basin area.

Prior to 1970, the Lepidoptera collection was housed in several areas in the Department of Zoology. With the recently added space and development of the new insect range in the George H. Brimhall Building, the moths and butterflies are being systematically arranged into more than 250 drawers.

I wish to express my appreciation for the opportunity of working with the university collection and with the staff members of the

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Figs. 1-8. *Cynthia* spp.: 1, *cardui*, dorsal aspect; 2 *cardui*, ventral aspect; 3, *cardui* ab. *elymi*, dorsal aspect; 4, *cardui* ab. *elymi*, ventral aspect; 5, *carye*, dorsal aspect; 6, *carye*, ventral aspect; 7, *carye* ab. *mulleri*, dorsal aspect; 8, *carye* ab. *mulleri*, ventral aspect.

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department. The facilities provided by the university through Dr. Joseph Murphy, chairman of the Department of Zoology, and the aid and advice given by Drs. Vasco M. Tanner and Stephen L. Wood are greatly appreciated.

I am grateful to Dr. W. Revell Phillips, Department of Geology, for his cooperation and assistance in making the accompanying photographs.

The following discussion and figures of rare aberrant forms of *Cynthia cardui* Linnaeus and *C. carye* Huebner are based upon specimens in the Brigham Young University collection and my personal one. These aberrant forms have not previously been reported from this area.

No attempt is made here to consider the various anatomical factors which form the basis for the classification of these species or the characteristics that depart from the normal type.

The Painted Lady

Cynthia cardui (Linnaeus, 1758)

This species (Figs. 1 and 2) is probably the most universally distributed butterfly, found worldwide except in the Arctic, the Antarctic, and South America. *Cynthia cardui* often occurs in Utah during April and May in migrating swarms. A form, *kershawi*, is reported from some Pacific Islands, Australia, and New Zealand.

The Brigham Young University collection of Lepidoptera contains a specimen (Figs. 3 and 4) which, with slight variation, compares favorably with the aberrant form *C. cardui elymi* Rambur (1829) as illustrated by J. A. Comstock (Butterflies of California, plate 42, Fig. 8). This butterfly was collected 27 Aug. 1925 by Ashby D. Boyle near his residence in Salt Lake City, Utah. At that late date in the year, the specimen appeared to be the product of a local generation rather than migration.

Martin and Truxal (1955) list four specimens of *C. c. elymi* in the Los Angeles County Museum. All are from California, collected from March to June; Leighton (1946) reports specimens of *C. c. elymi* from the state of Washington; and Dimock (1968) describes inducing experimental aberrations of *C. cardui* by chilling the pupae for 14 days at 36°F.

The Western Painted Lady

Cynthia annabella Field, 1971

This species (Figs. 5 and 6) ranges along the west coast of the United States and as far east as Utah and Colorado.

Field (1971) designated this North American population as a new species: *Cynthia annabella* relegating the name *Cynthia carye* Hübner to the South American representative.

Aberrant individuals occur in California and, I suspect, over the territory where they breed but are overlooked because the per-

centage of aberrant individuals is small. *Cynthia annabella* is often mistaken for *C. cardui*. A small number of *C. annabella* often appear, together with *C. cardui* on their northward flights, in Utah during April and May.

On 30 July 1957 I was fortunate to net a *C. carye muelleri* Letcher (Figs. 7 and 8) on a larkspur flower in my garden in Salt Lake City, Utah.

Cynthia annabella ab. *muelleri* Rambur (1898), *C. annabella* ab. *elymi* Rambur (1829), and *C. virginiensis* ab. *ahwashtee* Fox (1921) show the same type of maculation, probably an atavistic tendency, suggestive of a prototype of this group.

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NOMENCLATURAL PROBLEMS CONCERNING THE GENERIC AND FAMILIAL NAMES FOR THE NEW ZEALAND AND AMERICAN RIBBED FROGS

James D. Fawcett[1] and Hobart M. Smith[1]

Although information concerning many aspects of the life history and physiology of New Zealand's native frogs remains sparse or lacking, evolutionary and anatomical interest in the group has markedly increased during the last 50 years. It is therefore rather surprising to note the current uncertainty among herpetologists, zoogeographers, and anatomists concerning the spelling of the generic name and the correct application of a family-group name to these animals.

The relevant historical facts concerning the spelling of the generic name are as follows: Fitzinger (1861:218) described two specimens which had been collected by the Austrian naturalist Dr. v. Hochstetter on Coromandel Peninsula and named them *Leiopelma hochstetteri*. Seven years later, Günther (1868:478) of the British Museum altered the generic spelling to *Liopelma*, and the New Zealand frogs were, with but three exceptions (Steindachner, 1867: 33; Aitken, 1870:87; Sievers, 1895:264), consistently known by this name during the following 73 years. Important publications using Günther's emendation and thereby stabilizing the spelling are Boulenger's (1882) *Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum*, Gadow's (1901) *Amphibia and Reptiles*, and Noble's classic works dealing with amphibian phylogeny extending from 1922 to 1931. During this period, workers in New Zealand such as Hutton (1873), McCulloch (1919), Archey (1922), and Oliver (1925-27) followed Günther's lead.

Turbott (1942:247) drew attention to Günther's spelling change and emphasized the fact that Fitzinger's original spelling should be retained. This view was later reiterated by Myers and Carvalho (1945:17, footnote 5), Mittleman and Myers (1949:57, footnote 1), and Stephenson (1951:18, footnote). The usage of *Leiopelma* by Drs. N. G. and E. M. Stephenson in their recent series of detailed studies on all three species of the genus (*L. hochstetteri*, *L. hamiltoni*, and *L. archeyi*) has no doubt been largely responsible for the increased popularity of Fitzinger's spelling during the last 20-odd years.

Using primary literature sources since 1861, we have counted the number of authors (not works) using *Leiopelma* Fitzinger, 1861, and *Liopelma* Günther, 1868 (Table 1). During the 1960s there was a fourfold increase in favor of *Leiopelma*. Interestingly, since 1950

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TABLE 1. Number of authors using *Leiopelma* Fitzinger, 1861, and *Liopelma* Günther, 1868, from 1861 to 1970.

Time span	*Leiopelma*		*Liopelma*		Combined total
	No.	Percent	No.	Percent	
1861-1939	3	10.3	26	89.7	29
1940-1949	7	63.6	4	36.4	11
1950-1959	16	66.7	8	33.3	24
1960-1970	47	79.7	12	20.3	59

all New Zealand workers, so far as we are aware, have consistently employed *Leiopelma* in their writings.

Article 32 (a) (ii) of the International Code of Zoological Nomenclature (1964) makes it clear that *Liopelma* Günther, 1868, is an unjustified emendation and therefore is a junior objective synonym of *Leiopelma* Fitzinger, 1861. Strict application of the Law of Priority (Art. 23) would ensure the stability and universality of the currently more widely used senior synonym. Accordingly, we have appealed to the International Commission on Zoological Nomenclature for validation of *Leiopelma* Fitzinger, 1861, and suppression of *Liopelma* Günther, 1868.

Recent uncertainty concerning the correct application of a family-group name to these animals has been due in part to a question of priority and in part to a lack of agreement concerning the spelling of the type-genera (see above). The oldest family-group name, Liopelmatina, was proposed by Mivart (1869:291). Article 34 (a) allows revision of Mivart's spelling to Liopelmatidae. As mentioned above, *Liopelma* Günther, the type-genus of Liopelmatidae, is a junior objective synonym of *Leiopelma* Fitzinger, 1861. Article 40 states that a family-group name based on a junior objective synonym is not to be changed unless an alternate name has won general acceptance.

Four alternate names have been proposed. They include, in chronological order, the (1) Ascaphidae Féjérvary (1923:178): Féjérvary originally proposed this name for the North American ribbed frog *Ascaphus* Stejneger (1899:899), a monotypic genus containing only *A. truei* Stejneger; (2) Liopelmidae Noble (1924: 9): proposed as new but actually an erroneous spelling variant of Liopelmatidae Mivart, this family was created for both *Ascaphus* and *Liopelma* Günther, following "present day custom in using the oldest generic name in forming the family name"; (3) Leiopelmidae Turbott (1942:247): Turbott noted that "Fitzinger's original spelling, . . . , should be retained and extended to the family name"; (4) Leiopelmatidae Stephenson (1951:18). The Lipelmidae Romer (1933:437) is an erroneous subsequent spelling without nomenclatural status. Numbers 3 and 4 are nomenclatural equivalents, the latter being a justified emendation of Turbott's name.

It is true, apparently, that the name Ascaphidae has been used more frequently than any other name during the last 40 years; it

has been used regularly in the Zoological Record during that time (with Leiopelmidae, 1959-1963). We have sampled the works of 54 authors who discuss both *Leiopelma* and *Ascaphus*, thereby recording a preference for one of the family names enumerated above. Of these, Ascaphidae had 20 usages, Liopelmidae 14, Leiopelmidae 10, Liopelmatidae 2, and Leiopelmatidae 9. Thus, although 20 authors used Ascaphidae, more than any other one name, 35 used one of the four variations based on the genus *Leiopelma* Fitzinger. Hence, lacking general acceptance of an alternate name for the Liopelmatidae, Mivart's name should be retained. However, it is undesirable for the family name not to reflect the correct original spelling of the generic name. Accordingly, we have petitioned the International Commission on Zoological Nomenclature through use of its plenary powers to emend Liopelmatidae to Leiopelmatidae, retaining Mivart's date (1869) and authorship.

Recently, some doubts have been raised concerning the confamilial status of *Ascaphus* and *Leiopelma*. Gorham (1966:1-2) recognizes the separate families Ascaphidae and Leiopelmatidae, without citation of source or justification, and Kuhn (1967:14) states "Ascaphidae . . . ; meist als synonym für Leiopelmatidae aufgefasst, neuerdings aber als selbstandige Familie anerkannt." However, it seems desirable to stabilize the present nomenclatural instability and place the family-group name Leiopelmatidae on the *Official List of Family-Group Names in Zoology* and leave the name Ascaphidae in abeyance until such time as these two genera can be convincingly shown to warrant the same or separate family names.

The appeals mentioned above appeared in August 1971 (Fawcett and Smith, 1971). During the following few months, the Commission will welcome any endorsements or objections from interested systematists prior to final consideration of the case.

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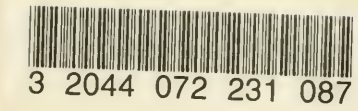
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